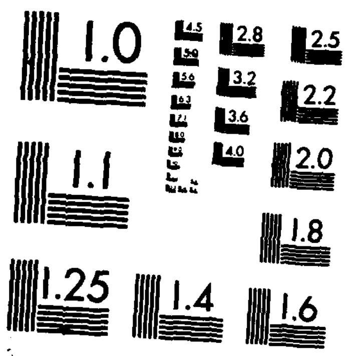
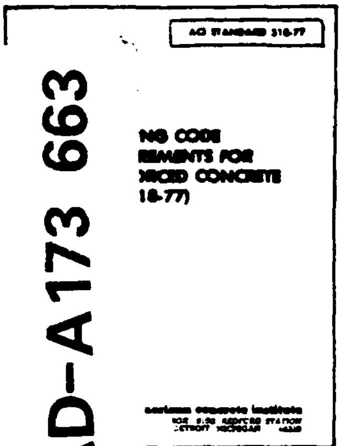
AD-A173 663 COMPUTER-AIDED STRUCTURAL ENGINEERING (CASE) PROJECT 1/6
DECISION LOGIC TABL (U) ATKINSON-NOLAND & ASSOCIATES
INC BOULDER CO J L NOLAND JUL 86 ATC-TR-86-5-VOL-1
UNCLASSIFIED DACW39-82-M-3741 F/G 9/2 NL

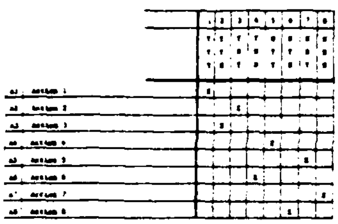


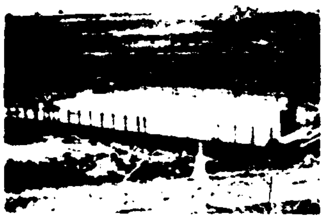
:CROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

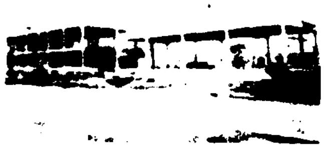
US Army Corps of Engineers

AD-A173 663









COMPUTER-AIDED STRUCTURAL ENGINEERING (CASE) PROJECT

TECHNICAL REPORT ATC-86-5

DECISION LOGIC TABLE FORMULATION OF ACI 318-77 BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE FOR AUTOMATED CONSTRAINT PROCESSING

Volume I

by

James L. Noland
Atkinson-Noland & Associates
2619 Spruce Street
Boulder, Colorado 80302

July 1986

Final Report

Approved For Public Release; Distribution Unlimited

Prepared for DEPARTMENT OF THE ARMY
US Army Corps of Engineers
Washington, DC 20314-1000

Under Contract No. DACW39-82-M-3741

Monitored by Automation Technology Center
US Army Engineer Waterways Experiment Station
PO Box 631, Vicksburg, Mississippi 39180-0631

Unclassified
SECURITY CLASSIFICATION OF THIS PAGE

ADA 173663

REPORT DOCUMENTATION PAGE

Form Approved
OMB No 0704 0188
Exp Date Jun 30, 1986

1a REPORT SECURITY CLASSIFICATION Unclassified	1b RESTRICTIVE MARKINGS
2a SECURITY CLASSIFICATION AUTHORITY	3 DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited
2b DECLASSIFICATION/DOWNGRADING SCHEDULE	
4 PERFORMING ORGANIZATION REPORT NUMBER(S) Technical Report ATC-86-5	5 MONITORING ORGANIZATION REPORT NUMBER(S)
6a NAME OF PERFORMING ORGANIZATION Atkinson-Noland & Associates 6b OFFICE SYMBOL (If applicable)	7a NAME OF MONITORING ORGANIZATION USAEWES Automation Technology Center
6c. ADDRESS (City, State, and ZIP Code) 2619 Spruce Street Boulder, CO 80302	7b ADDRESS (City, State, and ZIP Code) PO Box 631 Vicksburg, MS 39180
8a. NAME OF FUNDING/SPONSORING ORGANIZATION US Army Corps of Engineers 8b OFFICE SYMBOL (If applicable) DAEN-ECE-DS	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER Contract No. DACW39-82-M-3741
8c. ADDRESS (City, State, and ZIP Code) Washington, DC 20314-1000	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO / PROJECT NO / TASK NO / WORK UNIT ACCESSION NO

11 TITLE (Include Security Classification)
Decision Logic Table Formulation of ACI 318-77, Building Code Requirements for Reinforced Concrete for Automated Constraint Processing, Volumes I and II

12 PERSONAL AUTHOR(S)
Noland, James L.

13a TYPE OF REPORT	13b TIME COVERED	14 DATE OF REPORT (Year, Month, Day)	15 PAGE COUNT
Final Report	FROM ______ TO ______	July 1986	Vol I--486, Vol II--498

16 SUPPLEMENTARY NOTATION
Available from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. This report was prepared in two volumes with Volume I containing (See reverse)

17 COSATI CODES			18 SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	Building laws; Computer applications; Decision logic tables; Design--Standards; Reinforced concrete construction

19 ABSTRACT (Continue on reverse if necessary and identify by block number)

This report is concerned with the development of an automated constraint process based on an interconnected system of Decision Logic Tables (DLT). The tables were taken from the American Concrete Institute, Standard 318-77, Building Code Requirements for Reinforced Concrete, Chapters 7-18. Volume I includes Chapters 7-11, a concise grouping of design standard check lists for specific requirements pertaining to materials, construction, analysis, and design of buildings.

The DLT method can be applied to identify requirements of a given design as well as to check the design against applicable requirements. Assembled into two volumes and arranged by sections, this presentation affords the best plan for manual implementation. Proper DLT usage precludes misinterpretation and demands an examination of every possible combination and all logical alternatives. However, a step forward into automated constraint processing, i.e., the identification of applicable requirements for a given design and checking the design against those requirements via computer, would allow more effective and efficient utilization of complex standards.

20 DISTRIBUTION/AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	21 ABSTRACT SECURITY CLASSIFICATION Unclassified
22a NAME OF RESPONSIBLE INDIVIDUAL	22b TELEPHONE (Include Area Code) / 22c OFFICE SYMBOL

DD FORM 1473, 84 MAR — 83 APR edition may be used until exhausted. All other editions are obsolete

SECURITY CLASSIFICATION OF THIS PAGE
Unclassified

16. SUPPLEMENTARY NOTATION (Continued).

Chapters 7-11 and Volume II containing Chapters 12-18. Prepared under the Computer-Aided Structural Engineering (CASE) Project, these volumes have a list of published CASE reports printed on the inside of the back cover.

PREFACE

This report presents an interconnected system of Decision Logic Tables (DLT) which documents the logical alternatives and provisions of American Concrete Institute (ACI), Standard 318-77, Building Code Requirements for Reinforced Concrete. The DLTs were prepared and this report was completed by Atkinson-Noland & Associates, Inc. with Dr. James L. Noland, Professional Engineer, as principal investigator. The work was executed under contract DACW39-82-M-3741 with the US Army Engineer Waterways Experiment Station (WES) through funds provided to the Automation Technology Center (ATC), WES, by the Engineering and Construction Directorate of the Office, Chief of Engineers (OCE), under the Military programs portion of the Computer-Aided Structural Engineering (CASE) Project.

The purpose of the DLT formulation of the Code is to provide a basis for the development of an automated constraint processor based on ACI Standard 318. The need for the automated constraint processor was identified by the CASE Task Group on Building Systems. Members of the CASE Task Group (though many have not served for the entire period) during development of the DLTs and publication of the report are:

Mr. Dan Reynolds, Sacramento District (Chairman)
Ms. Anjana Chudgar, Louisville District
Mr. Joseph P. Hartman, Southwestern Division (formerly St. Louis District)
Mr. George Henson, Tulsa District
Mr. David Illias, Portland District
Mr. Sefton Lucas, Memphis District
Mr. Charles Myers, formerly St. Louis District
Mr. Jim Ouchi, Pacific Ocean Division
Dr. N. Radhakrishnan, formerly Special Technical Assistant, and present Chief, ATC, WES, was the CASE Project Manager and provided overall guidance.
Mr. David Raisanen, North Pacific Division
Mr. Peter Rossbach, Baltimore District
Mr. Paul K. Senter, Coordinator for the military programs work of this project, monitored the activities.
Mr. James Simmons, Baltimore District
Mr. Daniel Sommer, Omaha District
Mr. Robert Tom, Pacific Ocean Division

A subtask group composed of Messrs. Lucas (Chairman), Illias, and Raisanen provided detailed technical coordination and guidance during this period. Originally, Mr. George Matsumara and later Mr. Don Dressler were the OCE coordinators

for this task. Assisting this group and coordinating the revision of these volumes into WES format were Editor Gilda Shurden and Editorial Assistant Frances Williams, Publications and Graphic Arts Division.

COL Allen F. Grum, USA, was the previous Director of WES. COL Dwayne G. Lee, CE, is the present Commander and Director. Dr. Robert W. Whalin is Technical Director.

CONTENTS

	Page
PREFACE	1
PART I: INTRODUCTION	4
Documentation	4
Purpose	4
Background	4
PART II: DLT APPLICATION	14
Formulation	14
Format and Operational Conventions	16
REFERENCES AND BIBLIOGRAPHY	22
References	22
Bibliography	23
APPENDIX A: DECISION LOGIC TABLE FORMULATION OF ACI 318-77, BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE, CHAPTERS 7-18	A1
Chapter 7: Details of Reinforcement	A2
Chapter 8: Analysis and Design-General Considerations	A99
Chapter 9: Strength and Serviceability Requirements	A152
Chapter 10: Flexure and Axial Loads	A204
Chapter 11: Shear and Torsion	A317
*Chapter 12: Development and Splices of Reinforcement	A462
*Chapter 13: Two-Way Slab System	A575
*Chapter 14: Walls	A721
*Chapter 15: Footings	A750
*Chapter 16: Precast Concrete	A812
*Chapter 17: Composite Concrete Flexural Members	A830
*Chapter 18: Prestressed Concrete	A853

* Published separately in Volume II.

DECISION LOGIC TABLE FORMULATION OF ACI 318-77, BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE FOR AUTOMATED CONSTRAINT PROCEDURES

PART I: INTRODUCTION

Documentation

1. This report presents an interconnected system of Decision Logic Tables (DLTs) which document the logical alternatives and provisions of ACI Standard 318-77, Building Code Requirements for Reinforced Concrete for Automated Constraint Processing, Chapters 7-18.[1] The DLT formulations for Chapters 7-11 are contained in this volume and those for Chapters 12-18 are contained in Volume II. All information found in those chapters of the Code is contained in the DLT version.

Purpose

2. The DLT formulation of the Code will provide a foundation for the development of an automated constraint processor based on ACI Standard 318.

Background

Design standards

3. The term "design standard" used herein refers to the type of formal document which contains requirements applicable to a generic class of manufactured or constructed product. A design standard of specific interest is one that presents requirements pertaining to materials, construction, analysis, and design of buildings.

4. Design standards are an integral and extremely important component of the structural design-construction process and are intended to assure safety and welfare during construction and use of the structure, and proper performance.

> Designers and building regulator officials use design specifications to achieve a common understanding in order to effectively control designs. Specification writers translate knowledge of the environment, structural

behavior, and requirements for functionality and safety into usable requirements or practices in specification form.[2]

In addition, then, to serving as acceptance criteria, standards serve as guides during the design process.

Complexity of design standards

5. Design standards evolve as researchers, designers, material suppliers, and contractors revise or add requirements based upon increased knowledge and changing practices. Correspondingly, standards have often become extremely complex.

6. Complexity has been observed to be in two forms: textual organization complexity and logical complexity.[3]

7. Textual organization complexity. Textual organization complexity inhibits a user's ability to locate all the requirements which apply to a given design.[3,4] Requirements pertaining to a given member type, for example, may be found in several different sections of the standard. Accurate and complete implementation of requirements essentially depends upon the user's familiarity with a given standard.

8. Previous studies[5-7] have revealed, in an explicit manner, the organizational complexity and the underlying network of cross-references found in standards and document the difficulties which can be encountered in utilization of standards. A certain degree of organizational complexity is inherent, particularly in standards of a prescriptive nature. It has been suggested that a source of organizational complexity is new requirements being added and others being deleted or changed without fully exploring their interaction with other requirements.[8] Important work has been done to mitigate the problems of organizational complexity in design standards.[4,8-10]

9. Logical complexity. Design standards are logical systems in that the user is required to make a comparative study. Specific values of variables associated with a given design are compared to values presented in the standards in order to determine the applicable outcome. The lowest level of complexity occurs when an outcome can be determined on the basis of a single comparison. However, it is often necessary to make several comparisons before determining an outcome. In such cases the number of possible logical alternatives increases dramatically and accurate determination of the applicable outcome becomes increasingly difficult.

10. The ACI Standard 318-77 has been subdivided into parts, chapters, sections, and paragraphs in a manner which basically isolates provisions according to topic. Within a given paragraph logical complexity is often not a concern, although it is significant in many, as was discovered in previous work.[6,7] In numerous instances, several or all paragraphs within a section are interrelated, leading to extremely complex situations.

11. Paragraph 10.2.7(c) of ACI Standard 318-77 represents a relatively simple logical problem within the Code in which the value of a factor β is defined on the basis of the value of specified compressive strength of concrete f'_c used in design.

> Factor β shall be taken as 0.85 for concrete strengths up to and including 4000 psi. For strengths above 4000 psi, β shall be reduced continuously at a rate of 0.05 for each 1000 psi of strength in excess of 4000 psi, but β shall not be taken less than 0.65.

The user merely has to compare the value of the design variable f'_c used in a given design with the value 4,000 to identify the outcome. The proper value of β thus determined is used elsewhere to establish the depth of the compression stress zone for reinforced concrete in flexure.

12. Alternatively, paragraph 10.2.4 is more complex:

> Stress in reinforcement below specified yield strength f_y for grade of reinforcement used shall be taken as E_s times steel strain. For strains greater than that corresponding to f_y, stress in reinforcement shall be considered independent of strain and equal to f_y.

In this case the user must compare:

<u>a</u>. The value of reinforcement strain e_s in a given design with the yield strain e_y of that reinforcement.

<u>b</u>. The value of reinforcement stress f_s in the design with e_sE_s.

<u>c</u>. The value of reinforcement stress f_s in the design with yield stress of the reinforcement f_y.

Based on the results of the comparisons, the user may determine whether or not the provisions of paragraph 10.2.4 have been satisfied, i.e.,

<u>a</u>. If e_s is less than e_y and $f_s = e_sE_s$ and $f_s \neq f_y$, then provisions <u>are</u> satisfied.

<u>b</u>. If e_s is less than e_y and $f_s \neq e_sE_s$ and $f_s \neq f_y$, then provisions <u>are not</u> satisfied.

<u>c</u>. If e_s is greater than e_y and $f_s \neq f_y$, then provisions <u>are not</u> satisfied.

d. If e_s is greater than e_y and $f_s = f_y$, the provisions are satisfied.

Note that, implicit in this paragraph, there are two ways in which provisions are satisfied and two ways in which they are not.

Implications of complexity

13. Complexities, both textual organization and logical, tend to inhibit full and accurate utilization of design standards.[2,3,9] Organizational complexity leads to difficulties in locating requirements and to the possibility that all applicable requirements may not be implemented. Logical complexity can cause difficulty in accurate identification and checking of applicable requirements with an attendant chance of error. Both forms of complexity can have the effect of discouraging full use of design standards because it may be considered to be too time consuming.

14. While not directly a factor in complexity, the phraseology used to express requirements and other provisions in a standard can lead to ambiguity and misunderstanding. This problem has been analyzed and proposals have been made to aid in more precise narrative expression of standards[9,11] in future revisions of existing standards or in preparation of new standards.

Use of DLTs to analyze and document logically complex relations

15. Detailed and numerous requirements involving various degrees of logical complexity presented in the traditional narrative mode can be difficult to follow. Confusion arises due to lack of precise wording and events must be considered in a sequential manner. Flow charts, which are a semi-graphical description of a logical process, may also be difficult to follow as a presentation of a logical process.[3,6,12,13] Neither form offers a means for checking the accuracy or completeness of logical processes.[13]

16. The technique and format of DLTs are means for the analysis and documentation of logically complex processes and provide a firm basis for automation of such processes.[3,5,6,13] The analysis and presentation of standards in DLT format is also a prerequisite for textual organization analyses and restructuring of standards.[2,4,8-10] The structure of DLTs and manner of usage precludes misinterpretation, and the process of DLT formulation forces all logical alternatives to be examined.

17. A logical process essentially consists of determining the proper outcome for each of several possible combinations of events, depending upon

the relative state of the quantities associated with the process. An event associated with usage of a design standard is defined here as the relative state of any two quantities associated with a given topic. At least one of the quantities must be a design variable and possible relative states are equality and inequality.

18. Each comparison required to establish the relative state of two quantities is known as a "condition"; the result of the comparison is termed the "response"; the union of the comparison and response is an "event." As a result of an event or a combination of such events an outcome or "action" is taken. Conditions, responses, and actions then are the logical elements of a process or problem. A DLT is a tabular display of those elements. The formulation of a DLT constitutes a logical analysis of a given logical process, such that the resulting DLT presents all and the only logically correct combinations of design events which could arise from a given set of design quantities.[6] Methods have also been developed to check a given DLT for logical accuracy and completeness.[9]

19. DLTs have been developed with several variations of tabular form depending on the manner in which conditions, responses, and actions are presented. The "limited-entry" type of DLT has proven effective as an analytical device, a method of presentation, and a basis for automation.[4-6,9,12,13] The limited-entry type of DLT basically limits the response to a condition to a binary form, e.g., yes or no, positive or negative, or true or false. A typical tabular form for such a DLT is shown in Figure 1.

DLT Identification		1	2	3	4	5	6	7
	Condition Stub		Condition Entry					
	Action Stub		Action Entry					

Figure 1. Decision Logic Table layout

20. The DLT is divided into four quadrants by double horizontal and vertical lines. The upper left quadrant is defined as the "condition stub" and contains the condition or conditions which must be evaluated. The condition entry contains the various logically correct combinations of results which can be derived from the conditions. Outcomes (Actions) which can result from the various combinations of events presented in the upper half of the DLT are listed in the lower left quadrant--the action stub. The action entry contains indicators which serve to correlate the response combinations in the action entry with the appropriate action in the action stub. Each vertical column to the right of the double vertical lines in which a combination of responses is correlated with an outcome (action) is known as a "decision rule" and represents a unique path of logic. The leftmost column is provided so that conditions and actions may be numbered as C1, C2,...and A1, A2,....

21. An example of a DLT is presented in Figure 2 for a hypothetical logical process which requires that the value of variables x, y, and z be compared with constants A, B, and C, respectively. The conditions are cast into question form so that the response may be "yes" (Y) or "no" (N).*

22. The responses in a given response set are united with an "and" connective in order to represent a combination of events. Decision Rule 2 (column 2), for example, is interpreted as follows: If the response to C1 is Y, <u>and</u> the response to C2 is Y, <u>and</u> the response to C3 is N, <u>then</u> the outcome (indicated by the "X" in the action entry) is Action 3. In this manner the DLT has represented a combination of events $x = A$, $y > B$, and $z \geq C$ and correlated it with an outcome.

23. <u>Completeness concept.</u> Because a binary response form is associated with each condition, the number of unique sets of responses, i.e., unique combinations of events, stemming from n conditions is 2^n. A "complete" DLT must contain an account for all 2^n mathematically possible combinations of responses. A DLT which contains or implies more than 2^n response sets will have one or more duplications, i.e., redundant response sets. Alternatively, a DLT which contains or implies less than 2^n unique response sets may not account for all logically possible response sets (combinations of events).

24. The DLT of Figure 2 is, therefore, complete. Eight response sets

---

* It would be equally satisfactory to use "positive" (+) or "negative" (-) or any other binary form.

	DLT - Example 1	1	2	3	4	5	6	7	8
C1	Is x = A?	Y	Y	Y	Y	N	N	N	N
C2	Is y > B?	Y	Y	N	N	Y	Y	N	N
C3	Is z < C?	Y	N	Y	N	Y	N	Y	N
A1	Action 1	X							
A2	Action 2			X					
A3	Action 3		X						
A4	Action 4					X			
A5	Action 5							X	
A6	Action 6				X				
A7	Action 7								X
A8	Action 8						X		

Figure 2. Example of a DLT

presented account for all 2^3 possible unique response sets stemming from three conditions and, correspondingly, the union of the conditions and response sets describe all possible combinations of events.

25. Effect of dependent conditions. The conditions presented in Figure 2 are "independent," i.e., the response to any one of them has no influence on the response to the others. In many cases, however, in design standards and elsewhere, logical relationships are such that various interrelationships can occur between conditions. The response to one given condition may define the response to others and/or cause other conditions to become inapplicable.

26. This situation has been termed the case of "dependent" conditions. It has the effect of changing the number of logically correct combinations of events (hence the number of valid response sets) from 2^n to a lower number.[5,6]

27. A logical process in which outcomes are based upon the relative magnitude of a set of variables is an example of a case which results in a dependent-condition DLT. For example, assume that applicable design

requirements are based upon the relative magnitude of design variables x, y, and z. The relative magnitude states may be established by comparing the variables two at a time, i.e., by the set of conditions:

$$\{C\} = \begin{bmatrix} \text{Is } x > y? \\ \text{Is } x > z? \\ \text{Is } y > z? \end{bmatrix}$$

The logically correct combinations of events may be identified by forming the "relative magnitude" permutations:

$$x > y > z$$
$$x > z > y$$
$$y > x > z$$
$$y > z > x$$
$$z > x > y$$
$$z > y > x$$

By evaluating the conditions for each permutation, six logically correct response sets may be formed, i.e.,

$$\begin{bmatrix} Y & Y & Y & N & N & N \\ Y & Y & N & Y & N & N \\ Y & N & N & Y & Y & N \end{bmatrix}$$

The total number of response sets possible for the case of three conditions is $2^3 = 8$. The two response sets not shown

$$\begin{matrix} Y & N \\ N & Y \\ Y & N \end{matrix}$$

represent logically impossible combinations of events, i.e., "circular" relative magnitude permutations.

28. A decision rule termed "ELSE," for which the actions is an indication of a logical error in the evaluation of dependent conditions, may be used to account for all logically incorrect response sets.[6] A DLT containing dependent conditions is therefore "complete" if all logically correct response sets <u>and</u> an ELSE rule are present in the condition entry.* The DLT

---

* Other applications of DLTs have utilized the ELSE rule to represent all response sets not shown in the condition entry where only the response sets most likely to occur or associated with a single type of outcome are presented. ELSE rules thus used may represent logically correct response sets as well as logically incorrect ones.[4,5,8-10]

representation of the foregoing example is presented in Figure 3 with an "action" corresponding to each logically correct combination of events.

	DLT Dependent Conditions	1	2	3	4	5	6	
C1	Is x > y?	Y	Y	Y	N	N	N	ELSE
C2	Is x > z?	Y	Y	N	Y	N	N	
C3	Is y > z?	Y	N	N	Y	Y	N	
A1	Action 1			X				
A2	Action 2	X						
A3	Action 3				X			
A4	Action 4		X					
A5	Action 5						X	
A6	Action 6					X		
A7	Logical Error							X

Figure 3. Dependent-condition DLT example

29. Other forms of dependency among conditions can occur. Further, a given DLT may contain subsets of conditions which are independent and subsets of conditions which are not. The effect of the foregoing and other factors which affect the number of logically correct response sets and their formulation are discussed elsewhere.[6]

Automated constraint processing

30. The engineering design process requires a substantial amount of analytical effort to determine internal loads and resultant stresses and deformations of a given design. Automated procedures have been developed and are applicable to a wide range of structural analysis problems. In a few instances design constraints, i.e., requirements, are integral within analysis procedures and provide a certain level of assurance that a given design conforms to applicable requirements. The requirements that are contained in analytical procedures are basically intermingled, in an operational sense, with other operations and may be difficult to modify or update.

31. Generally, the implementation of standards in the design process is done in a manual fashion, i.e., by an individual or individuals reading a standard and attempting to extract all the requirements applicable to the design. The requirements thus obtained are used as a guide during design or to check a completed design. Because of Code complexity, full or accurate implementation of standards may not be done.

32. Automated constraint processing, i.e., identification of applicable requirements for a given design or checking a given design against applicable requirements by means of a computer, would permit complex standards to be more effectively and efficiently utilized. This capability would potentially expand the designer's ability to consider alternate concepts and devote a greater proportion of effort on optimality considerations. More rigorous checking of completed designs would give both the designer and user of the designs greater confidence regarding performance and safety.

33. A basic methodology has been developed for automated checking of designs against requirements.[5] The methodology is based upon a DLT formulation of the applicable standard to provide the necessary precision of expression relating design conditions to applicable requirements. Automated procedures for textual organization analysis and restructuring of standards also require a DLT formulation of a given standard.[2,4,8-10]

PART II: DLT APPLICATION

Formulation

Approach

34. The DLT method may be applied to design standards to identify requirements applicable to a given design or to serve primarily as a means for checking a given design against applicable requirements. These alternatives have been termed the "design approach" and the "checking approach," respectively.[5]

35. The two different approaches are illustrated in Figure 4 which treats a hypothetical situation of allowable stress σ depending on the relative magnitude of variables x and y .

36. The DLT formulation presented herein is based upon the "checking approach," i.e., the desired outcome is an indication of compliance or noncompliance with Code requirements.

	DLT Design Aid	1	2
C1	Is $x > y$?	Y	N
A1	$\sigma_{max} = 10000$	X	
A2	$\sigma_{max} = 5000$		X

a. Design approach

	DLT Checking	1	2	3	4	5	6	
C1	$x > y$?	Y	Y	Y	N	N	N	ELSE
C2	$\sigma < 5000$?	N	N	Y	N	N	Y	
C3	$\sigma < 10000$?	N	Y	Y	N	Y	Y	
A1	Provisions = satisfied		X	X			X	
A2	Provisions $\neq$ satisfied	X			X	X		

b. Checking approach

Figure 4. DLT usage

Organization

37. The DLT format of the ACI 318-77 Code is organized in the same way as the narrative version of the Code at the chapter and section level, but the DLT representation within a section may or may not follow the organization as presented in the narrative Code. The general policy followed for the DLT formulation of a section was to initially consider all criteria which established the applicability of paragraphs within a section to a given topic or subtopic and to consider topics or subtopics together. This occasionally resulted in consideration of the material in a section in a different order than that of the narrative version.

38. The DLT formulation of the Code utilizes three basic DLT types, i.e., "switching," "working," and "checking." A switching DLT routes the user to the areas of the Code of his interest. The actions in such DLTs are transfer statements which identify the next DLT to be followed. The initial DLT or DLTs of a Code chapter are the switching type which refers the user to the various sections within a chapter; such DLTs serve as Tables of Contents. Other smaller switching DLTs are utilized as required to direct the user to other applicable DLTs.

39. Working DLTs develop information based upon the value of design variables for subsequent use in checking DLTs. In general, it would be possible to rely solely upon checking DLTs. However, in many cases this would result in a very large DLT (in terms of the number of conditions and rules) which is more difficult to develop and use. Working DLTs permit a logical problem to be partitioned into more manageable components. The DLT of Figure 4 would be a working DLT if it were part of a checking system. It develops the value of σ_{max} against which the value of σ in a given design would be checked as in Figure 5.

	DLT Checking	1	2
C1	$\sigma < \sigma_{max}$?	Y	N
A1	Provisions = satisfied	X	
A2	Provisions ≠ satisfied		X

Figure 5. Checking DLT

40. A checking DLT, as shown in Figures 4 and 5, is one designed to indicate whether or not a requirement (provision) is satisfied. As shown in Figure 4, a checking DLT may internally develop information required for checking or information may be developed by an associated working DLT (Figures 4a and 5).

41. Each working and checking DLT contains one or more transfer statements that refer the user to the next appropriate DLT. If, within a given Code section, all DLTs associated with a specific topic have been used (executed) or further execution is not possible for another reason, the user is transferred to the chapter-level switching DLT to identify the next section, if any, which should be checked.

42. A given design topic may be subject to many requirements, all of which must be satisfied. A DLT applicable to that topic indicates whether or not a specified requirement has been satisfied. The user is then transferred to the next DLT or DLTs applicable to an additional requirement or requirements. It is important to note that, as presently configured, the ACI 318-77 DLT system does not terminate the checking process when violations are encountered. Subsequent checks, therefore, may not be valid if requirements checked following a violated requirement utilize some or all of the same design information.

Format and Operational Conventions

43. Format and operational conventions adopted for the conversions of ACI Standard 318-77 into DLT format are discussed in the following sections.

Phraseology

44. Where possible, conditions were formulated by using standard symbols for quantities as listed in the "Notation" to each Code chapter. Occasionally, new symbols were created to represent quantities used frequently for which no standard symbols already existed. Generally, however, conditions are stated using Code phraseology so that the DLT form of the Code would be directly ameanable to manual usuage. This was also done so that any subtleties of intent or meaning in the narrative form of the Code would be reflected in the DLT form. In most cases conditions are stated with introductory words implied, e.g., "is," "is the," "does," "does the," which are grammatically necessary to state a question. It is important to recognize that conditions stated in a narrative manner imply equality or inequality comparisons between

design quantities. However, frequently this is not obvious and symbols could very well be used to represent quantities now represented by words or phrases.

Compound conditions

45. The conditions in the DLTs of Figures 2-5 are examples of simple conditions, i.e., only two design factors are compared. Compound conditions enable more than two design factors to be considered at a time and have the effect that the size of a DLT, i.e., the number of conditions and decision rules, is smaller than if only paired comparisons are used. Compound conditions permit the phraseology of the Code to be followed more completely.

46. Compound conditions are characterized by the presence of "and" or "or" logical operators to correct the design factors.[6,9] The hypothetical conditions:

a. x and y and z > A? , and

b. x = A or B or C?

are examples of compound conditions. Other forms of compound conditions are possible and do occur.

47. Any one of the foregoing conditions, a or b, would result in a DLT of only two decision rules (i.e., two single-element response sets Y and N). The upper portion of DLTs containing the simple conditions implied in compound conditions a and b are shown in Figure 6. Note that the "or" operator in a compound condition leads to a set of simple conditions which are dependent.

The ELSE rule

48. The ELSE decision rule, as indicated in paragraph 28 herein, is used in the DLT ACI 318-77 to account for response sets which imply logically impossible combinations of events and are found in DLTs containing dependent conditions.

49. There is the possibility that a specific set of responses developing from the conditions of a given dependent-condition DLT will not match one of the sets contained in the conditions entry. In this case the ELSE rule indicates that a logical error exists in the response set developed. The user should examine the data from which the set was developed and reenter the DLT with a corrected set.

The immaterial (I) entry

50. Frequently, the number of outcomes (actions) available as a result of combinations of events represented in the upper portion of a DLT is less than the number of combinations of events (response sets). In this case, two

	DLT (a)	1	2	3	4	5	6	7	8
C1	x > A?	Y	Y	Y	Y	N	N	N	N
C2	y > A?	Y	Y	N	N	Y	Y	N	N
C3	z > A?	Y	N	Y	N	Y	N	Y	N

a. DLT corresponding to x <u>and</u> y <u>and</u> z > A?

	DLT (b)	1	2	3	4	
C1	x = A?	Y	N	N	N	E L S E
C2	x = B?	N	Y	N	N	
C3	x = C?	N	N	Y	N	

b. DLT corresponding to x = A <u>or</u> B <u>or</u> C?

Figure 6. Simple-condition DLTs equivalent to compound-condition DLTs

or more response sets will be correlated with the same action or actions. In general, groups of two or more response sets may be correlated with actions associated with the sets of each group.

51. One or more sets of responses with a common action or actions may be combined (merged) by using the immaterial (I) entry as a response to the condition or conditions with opposite responses. Because a response set with an I in r positions represents 2^r "pure" sets, i.e., those containing only Ys or Ns , only even numbers of response sets can be combined and retain the logical integrity of the condition entry.

52. As an example, assume that the action set of Figure 3 is changed to that shown in Figure 7a. Decision Rules 1 and 2, 3 and 4, and 5 and 6 each result in a common outcome. Decision Rules 1 and 2 have common responses to C1 and C2 but not to C3. C3 is then the immaterial response and may be replaced by an I . Similarly, the response to C3 may be an I for Decision

	DLT Dependent Conditions - 2	1	2	3	4	5	6	
C1	Is x > y?	Y	Y	Y	N	N	N	ELSE
C2	Is x > z?	Y	Y	N	Y	N	N	
C3	Is y > z?	Y	N	N	Y	Y	N	
A1	Action 1			X	X			
A2	Action 2					X	X	
A3	Action 3	X	X					
A4	Logical Error							X

a. Before reduction

	DLT Dependent Conditions - 3	1	2	3	4	
C1	x > y?	Y	Y	N	N	ELSE
C2	x > z?	Y	N	Y	N	
C3	y > z?	I	N	Y	I	
A1	Action 1		X	X		
A2	Action 2				X	
A3	Action 3	X				
A4	Logical Error					X

b. After reduction

Figure 7. DLT reduction

Rules 5 and 6. Rules 3 and 4 may not be combined because their responses to conditions C1, C2, and C3 are opposite, i.e., more of the responses are immaterial. The reduced DLT is shown in Figure 7b.

53. Note that the original condition entry of Figure 7a may be developed by replacing each I in a decision rule with a Y and an N and repeating the responses to the other conditions.

54. DLT reduction is accomplished by examining the action entry for

multiple indicators, x , opposite an action or actions. The associated response sets may then be examined in multiples of two for merging as previously described.

55. Others[5,8-10] have reduced the size of DLTs by retaining only response sets and responses within those sets associated with a particular action or actions. This results in a DLT smaller than one reduced in accordance with the approach previously described with attendant increase in efficiency of utilization. A DLT so reduced, in general, does not retain the ability to check an input response set for logical validity and may imply contradictory or logically incorrect response sets.[6]

56. The initial DLT formulation of ACI Standard 318-77 presented herein has been done in a manner such that any DLTs containing I entries may be expanded to their original form containing all and only logically correct response sets.

The blank entry

57. A blank in a response set opposite a condition indicates that the response to that condition is "inapplicable"; i.e., because of the events implied by the other responses in the response set, an event associated with a certain condition is not possible. This phenomenon occurs when a DLT contains conditions or subsets of conditions associated with different topics. Such DLTs could be separated into two or more separate DLTs linked together; however, it is often convenient to consider the conditions in a single DLT.[6]

The order of considering actions

58. Actions are intended to be considered sequentially in the DLT ACI 318-77 with the last action being a transfer statement. In several cases an action cannot be taken, e.g., a value determined, without a value from a preceding action.

Comments

59. A Comment is appended to each DLT to indicate which portion of the Code is covered. Additional comments may be made to discuss assumptions regarding Code interpretation necessary for DLT formulation and to provide explanatory information.

Footnotes

60. Footnotes may be appended to a DLT as required to include Code information of a supporting or clarifying nature, yet not integral to the logical process.

Datum Tables

61. Each DLT is preceded by a "Datum Table" which lists all data necessary to execute the DLT, the source, and the data symbols, if any. The symbols (labels) are taken from Code notation, if available and some symbols have been coined for convenience. Datum which is provided by the user is indicated by an "X" and datum which is developed by other DLTs is indicated by the source DLT identification. The "Number" column in a Datum Table is provided for possible future use in reorganization studies.[9]

DLT and datum table identification

62. Tables are identified by the section of the chapter treated and lettered consecutively a, b, c,.... The order of the tables is not necessarily the same as the order in which topics are treated within a section of the Code.

Entering and exiting DLTs at section level-- manual usage of the system

63. An individual user arrives at a given section of the Code within a chapter by using the Index DLT for that chapter, e.g., DLT Chapter 10. The index DLTs were developed on the assumption that a user would be interested in the provisions of one section at a time.

64. DLTs at the section level are organized so that questions of applicability of a section, if any, are addressed initially. If applicable, the user is transferred to the proper DLTs in a specified sequence. Some sections of the Code are such that not all of the DLTs will be executed for a given situation. After all applicable DLTs have been executed, the user is switched back to the Chapter Index DLT to determine any additional chapter sections against which a given design should be checked.*

---

* The DLT ACI 318-77, as does the narrative form of the Code, relies upon the user to select the parts of the Code which are to be checked.

REFERENCES AND BIBLIOGRAPHY

References

1. American Concrete Institute, "Building Code Requirements for Reinforced Concrete (ACI 318-77)," ACI Standard 318-77, Dec 1977, Detroit, Mich.; also, "Commentary on Building Code Requirements for Reinforced Concrete (ACI 318-77)," ACI Committee Report, Dec 1977, Detroit, Mich.

2. Fenves, S. J., and Wright, R. N., "The Representation and Use of Design Specifications," NBS Technical Note 940, Center for Building Technology, Institute for Applied Technology, National Bureau of Standards, Washington, D. C., June 1977.

3. Noland, J. L., "Logical Complexity in Engineering Specifications," Methods of Structural Analysis, Saul and Peyrot, ed., American Society of Civil Engineers, Aug 1976.

4. Harris, J. R. et al., "Technology for the Formulation and Expression of Specifications," Vol I: Final Report, Civil Engineering Studies, Structural Research Series No. 423, University of Illinois, Urbana, Ill., Dec 1975.

5. Goel, S. K., and Fenves, S. J., "Computer-Aided Processing of Structural Design Specifications," Civil Engineering Studies, Structural Research Series No. 348, University of Illinois, Urbana, Ill., Nov 1969.

6. Noland, J. L., Formulation of Decision Logic Tables and Their Application to Engineering Specifications, Ph. D. Dissertation, University of Colorado, Boulder, Colo., 1975.

7. Griebenow, R. G., Decision Logic Table Design-Aid System for the American Concrete Institute Concrete Code, M.S. Thesis, University of Colorado, Boulder, Colo., 1976.

8. Nyman, D. J., Fenves, S. J., and Wright, R. N., "Restructuring Study of the American Institute of Steel Construction Specification," Civil Engineering Studies, Structural Research Series No. 393, University of Illinois, Urbana, Ill., Jan 1973.

9. Harris, J. R., and Wright, R. N., "Organization of Building Standards: Systematic Techniques for Scope and Arrangement," NBS Building Science Series 136, National Engineering Laboratory, National Bureau of Standards, Washington, D. C., Sept 1981.

10. Nyman, D. J., and Fenves, S. J., An Organizational Model for Design Specifications, Department of Civil Engineering, Carnegie-Mellon University, Pittsburgh, Pa., Sept 1975.

11. Fenves, S. J., Rankin, K. R., and Tejuja, H. K., "The Structure of Building Specifications," Building Science Series 90, Center for Building Technology, Institute for Applied Technology, National Bureau of Standards, Washington, D. C., Sept 1976.

12. Fenves, S. J., Gaylord, E. H., and Goel, S. K., "Decision Logic Table Formulation of the American Institute of Steel Construction Specification," Civil Engineering Studies, Structural Research Series No. 347,

University of Illinois, Urbana, Ill., Aug 1969.

13. McDaniel, H., An Introduction to Decision Logic Tables, John Wiley, 1968.

Bibliography

1. American Institute of Steel Construction, Specifications for the Design, Fabrication, and Erection of Structural Steel Buildings, 1969.

APPENDIX A: DECISION LOGIC TABLE FORMULATION OF ACI 318-77

BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE

CHAPTERS 7-11

ACI CHAPTER 7: DETAILS OF REINFORCEMENT

DLT	Chapter 7- 1	1	2	3	4	5	6	7	8
C1	Hooks?	Y	N	N	N	N	N	N	
C2	Bend Diameters?	N	Y	N	N	N	N	N	E
C3	Bending Procedure?	N	N	Y	N	N	N	N	L
C4	Surface Condition?	N	N	N	Y	N	N	N	S
C5	Placement?	N	N	N	N	Y	N	N	E
C6	Spacing?	N	N	N	N	N	Y	N	
A1	Section 7.1	X							
A2	Section 7.2		X						
A3	Section 7.3			X					
A4	Section 7.4				X				
A5	Section 7.5					X			
A6	Section 7.6						X		
A7	DLT Chapter 7- 2							X	
A8	Logical Error								X

DLT	Chapter 7 - 2	1	2	3	4	5	6	7	8
C1	Concrete Protection?	Y	N	N	N	N	N	N	
C2	Columns - Special Details?	N	Y	N	N	N	N	N	E
C3	Connections?	N	N	Y	N	N	N	N	L
C4	Lateral Reinforcement for Compression Members?	N	N	N	Y	N	N	N	S
C5	Lateral Reinforcement for Flexural Members?	N	N	N	N	Y	N	N	E
C6	Shrinkage & Temperature Reinforcement?	N	N	N	N	N	Y	N	
A1	Section 7.7	X							
A2	Section 7.8		X						
A3	Section 7.9			X					
A4	Section 7.10				X				
A5	Section 7.11					X			
A6	Section 7.12						X		
A7	DLT 318-77 Index							X	
A8	Logical Error								X

Section 7.1 Standard Hooks

Datum 7.1(a)	Source	Label	Number
If Hook Type = Stirrup or Tie Hook	X		

DLT 7.1(a)	Hook Type	1	2
C1	Hook Type = Stirrup or Tie Hook?	Y	N
A1	DLT 7.1(b)	X	
A2	DLT 7.1(c)		X

Comment: 1) DLT 7.1(a) partially covers Section 7.1.

Datum 7.1(b)	Source	Label	Number
Bend angle of bar	X		
Extension at free end of bar	X		

DLT 7.1(b)	Hook Check 1	1	2	3
C1	Bend angle = 90° <u>or</u> 135°?	Y	Y	N
C2	Extension = min[$6d_b$,*$2\frac{1}{2}$"]?	Y	N	I
A1	Provisions = Satisfied	X		
A2	Provisions ≠ Satisfied		X	X
A3	DLT Chapter 7-1	X	X	X

Comment: 1) DLT 7.1(b) covers part (c) of Section 7.1.

---

* For convenience, symbols and unusual abbreviations are listed and defined in the Notation at the end of each chapter.

Datum 7.1(c)	Source	Label	Number
Bend Angle of Bar	X		
Extension at Free End of Bar	X		

DLT 7.1(c) Hook Check 2		1	2	3	4
C1	Bend = 180° and extension ≥ min[$4d_b$, $2\frac{1}{2}$"]?	Y	N	N	ELSE
C2	Bend = 90° and extension ≥ 12 d_b?	N	Y	N	
A1	Provisions = Satisfied	X	X		
A2	Provisions ≠ Satisfied			X	
A3	DLT Chapter 7-1	X	X	X	
A4	Logical Error				X

Comments:

1) **For closed ties defined as hoops in Appendix A, a 135-deg bend plus an extension of at least $10d_b$ (see Section a.2).**

2) **DLT 7.1(c) covers parts (a) and (b) of Section 7.1.**

Section 7.2 Minimum Bend Diameters

Datum 7.2(a)	Source	Label	Number
Bend Use	X		
Type of Reinforcement	X		

DLT 7.2(a) Bend Data		1	2	3	4	5	6
C1	Bend for Stirrup <u>or</u> Tie?	N	N	Y	Y	Y	ELSE
C2	Bend in Bar Reinforcement?	Y	N	Y	N	N	
C3	Bend in Welded Wire Fabric (WWF)?	N	I	N	Y	N	
A1	DLT 7.2(b)	X					
A2	DLT 7.2(c)			X			
A3	DLT 7.2(f)				X		
A4	No Provision		X			X	
A5	DLT Chapter 7-1		X			X	
A6	Logical Error						X

Comment: 1) DLT 7.2(a) is a switching DLT.

Datum 7.2(b)	Source	Label	Number
Grade of Steel	X		
Bar Size	X		
Bend Angle	X		

DLT 7.2(b) Bends in Bars - Gr 40		1	2
C1	Bar = GR 40 <u>and</u> Size = #3 through #11 <u>and</u> Bend Angle = 180°?	Y	N
A1	Minimum Diameter of Bend (MDB) $\geq 5\ d_b$	X	
A2	DLT 7.2(d)		X
A3	DLT 7.2(e)	X	

Comment: 1) DLT 7.2(b) partially covers Section 7.2.1.

Datum DLT 7.2(c)	Source	Label	Number
Bar Size	X		

DLT 7.2(c) Bends in Bars for Stirrups or Ties		1	2
C1	Bar Size $\leq$ #5?	Y	N
A1	MDB $\geq 4\ d_b$	X	
A2	DLT 7.2(d)		X
A3	DLT 7.2(e)	X	

Comment: 1) DLT 7.2(c) partially covers Section 7.2.2.

Datum DLT 7.2(d)	Source	Label	Number
Bar Size	X		

DLT 7.2(d) Minimum Diameter of Bend		1	2	3	4	5
C1	Bar Size = #3 through #8?	Y	N	N	N	E L S E
C2	Bar Size = #9, #10, or #11?	N	Y	N	N	
C3	Bar Size = #14 or #18?	N	N	Y	N	
A1	MDB = 6 d_b	X				
A2	MDB = 8 d_b		X			
A3	MDB = 10 d_b			X		
A4	No Provision				X	
A5	DLT 7.2(e)	X	X	X		
A6	DLT Chapter 7-1				X	
A7	Logical Error					X

Comment: 1) DLT 7.2(d) partially covers Sections 7.2.1 and 7.2.2.

Datum DLT 7.2(e)	Source	Label	Number
Bend Diameter	X		
MDB	DLT 7.2(b,c,d)		

DLT 7.2(e)	MDB Check for Bars	1	2
C1	Bend Diameter $\geq$ MDB?	Y	N
A1	Provisions = Satisfied	X	
A2	Provisions $\neq$ Satisfied		X
A3	DLT Chapter 7-1	X	X

Comment: 1) DLT 7.2(e) partially covers Sections 7.2.1 and 7.2.2.

Datum DLT 7.2(f)	Source	Label	Number
Wire Size	X		
Wire Condition (Deformed or Smooth)	X		

DLT 7.2(f) Bends in WWF for Stirrups and Ties		1	2
C1	Deformed Wire Larger than D6?	Y	N
A1	MDB $\geq 4\ d_b$	X	
A2	MDB $\geq 2\ d_b$		X
A3	DLT 7.2(g)	X	X

Comment: 1) DLT 7.2(f) partially covers Section 7.2.3.

Datum DLT 7.2(g)	Source	Label	Number
Bend Diameter	X		
Minimum Bend Diameter	DLT 7.2(f)	d_b	
Location of Bend	X		

DLT 7.2(g)	Check Bend Diameter in WWF	1	2	3	4	5
C1	Bend Diameter $\geq$ MDB?	Y	Y	N	Y	ELSE
C2	Bend Diameter $\geq 8\ d_b$?	Y	N	N	I	
C3	Location of Bend $< 4\ d_b$ from nearest welded intersection ?	Y	Y	I	N	
A1	Provisions = Satisfied	X			X	
A2	Provisions $\neq$ Satisfied		X	X		
A3	DLT Chapter 7-1	X	X	X	X	
A4	Logical Error					X

Comment: 1) DLT 7.2(g) covers Section 7.2.3.

Section 11.3 Bending

Datum 7.3(a)	Source	Label	Number
Bending method, i.e., hot or cold	X		
Hot bending approval	X		

DLT 7.3(a) Bending Check 1		1	2	3
C1	Reinforcement to be bent cold?	Y	N	N
C2	Hot bending permitted by the Engineer?	I	Y	N
A1	Provision = satisfied	X	X	
A2	Provision ≠ satisfied			X
A3	DLT 7.3(b)	X	X	
A4	DLT Chapter 7-1			X

Comments:

1) "Otherwise permitted by the Engineer" in Section 7.3.2 is interpreted to mean bending of bars heated as suggested in the Commentary.

2) DLT 7.3(a) covers Section 7.3.1.

Datum 7.3(b)	Source	Label	Number
State of reinforcement embedment, i.e., full or partial.	X		
Field bending of partially embedded reinforcement done or planned.	X		
Field bending shown on design drawings.	X		
Field bending approved by the Engineer.	X		

DLT 7.3(b) Bending Check 2		1	2	3
C1	Field bending of reinforcement partially embedded in concrete done or planned?	Y	Y	N
C2	Field bending shown on design drawings or permitted by the Engineer?	Y	N	I
A1	Provision = satisfied	X		X
A2	Provision ≠ satisfied		X	
A3	DLT Chapter 7-1	X	X	X

Comment:

1) DLT 7.3(b) covers Section 7.3.2.

Section 7.4 Surface Conditions of Reinforcement

Datum 7.4(a)	Source	Label	Number
Reinforcement Type	X		

DLT 7.4(a) Surface Condition		1	2
C1	Reinforcement Type = Prestressing Tendon?	Y	N
A1	DLT 7.4(b)	X	
A2	DLT 7.4(c)		X

Comments:

1) It is assumed that if the type of reinforcement is not prestressing tendon, it is conventional bar or wire.

2) It is assumed that Sections 7.4.1 and 7.4.2 apply to conventional reinforcement and that 7.4.3 was meant to apply to prestressing tendons.

3) DLT 7.4(a) is a switching DLT.

Datum 7.4(b)	Source	Label	Number
Presence of oil, dirt, scale, <u>or</u> excessive rust	X		
Presence of heavy oxide	X		

DLT 7.4(b)	Requirement for Tendon Surface Condition	1	2	3
C1	Tendon clean and free of oil, dirt, scale, pitting <u>and</u> excessive rust?	Y	Y	N
C2	Heavy oxide present?	Y	N	I
A1	Provision = satisfied		X	
A2	Provision ≠ satisfied	X		X
A3	DLT Chapter 7-1	X	X	X

Comments:

1) No criteria provided to define "heavy" oxide or "excessive" rust.

2) DLT 7.4(b) covers Section 7.4.3.

Datum 7.4(c)	Source	Label	Number
Presence of rust or mill scale.	X		
Minimum dimensions (including height of deformations) and weight of hand wire brushed specimen.	X		
Applicable ASTM requirements.	X		

DLT 7.4(c)	Reinforcement Surface Condition Requirement 1	1	2	3
C1	Rust or mill scale present?	Y	Y	N
C2	Minimum dimensions (including height of deformations and weight of hand wire brushed specimen ≥ applicable ASTM specification requirements?	Y	N	I
A1	Provisions = satisfied	X		X
A2	Provisions ≠ satisfied		X	
A3	DLT 7.4(d)	X	X	X

Comments:

1) It is assumed that if no rust or mill scale is present, then minimum dimensions will be acceptable.

2) Applicable ASTM requirements are listed in the Code.

3) DLT 7.4(c) covers Section 7.4.2.

Datum 7.4(d)	Source	Label	Number
Presence of mud, oil, or other non-metallic coatings which adversely affect bonding capacity.	X		

DLT 7.4(d)	Reinforcement Surface Condition Requirement 2	1	2
C1	Was or is reinforcement at the time of placing free of mud, oil, or other non-metallic coatings that adversely affect bonding capacity?	Y	N
A1	Provision = satisfied	X	
A2	Provision ≠ satisfied		X
A3	DLT Chapter 7-1	X	X

Comment: 1) DLT 7.4(d) covers Section 7.4.1.

Section 7.5 Placing Reinforcement

Datum 7.5(a)	Source	Label	Number
Type of reinforcement material.	X		

DLT 7.5(a) Material Type		1	2	3	4
C1	Material = welded wire fabric (WWF)?	Y	N	N	ELSE
C2	Material = reinforcement, prestressing tendons, or prestressing ducts?	N	Y	N	
A1	DLT 7.5(b)		X		
A2	DLT 7.5(g)	X			
A3	No provision : DLT Ch. 7-1			X	
A4	Logical Error			X	X

Comment: 1) DLT 7.5(a) is a switching DLT.

Datum 7.5(b)	Source	Label	Number
If Engineer-specified tolerances provided.	X		

DLT 7.5(b)	Specified Tolerances	1	2
C1	Placement tolerances provided by the Engineer?	Y	N
A1	DLT 7.5(c)		X
A2	DLT 7.5(f)	X	

Comment: 1) DLT 7.5(b) covers Section 7.5.2.

Datum 7.5(c)	Source	Label	Number
Element type, e.g., wall, flexural member, compression member.	X		
If clear distance is measured to a formed soffit.	X		
Minimum concrete cover required in contract drawings or in the specifications, in.	X	MCCD	

DLT 7.5(c)	Tolerance Requirements Td & MCC	1	2	3	4	5	6
C1	Element = wall, flexural member or compression member?	N	Y	Y	Y	Y	E L
C2	Clear distance measured to a formed soffit?	I	Y	N	Y	N	S E
C3	d $\leq$ 8 in.?	I	Y	Y	N	N	
A1	TMCC = minimum [1/4 in., 1/3 MCCD]		X		X		
A2	Td = 3/8 in.		X	X			
A3	TMCC = minimum [3/8 in., 1/3 MCCD]			X		X	
A4	Td = 1/2 in.				X		
A5	TMCC = minimum [1/2 in., 1/3 MCCD]					X	
A6	No provision for Td or MCCD	X					
A7	DLT 7.5(d)	X	X	X	X	X	
A8	Logical Error						X

Comments:

1) In the above form, this DLT produces two data, i.e., TMCC and Td. It would be split into two DLTs, one for TMCC and one for Td, to comply with requirements for automation using the information network approach.

2) Soffit = the underside of a horizontal member which projects beyond a wall line such as an overhanging roof.

3) The additional requirement that the cover shall not be reduced by more than 1/3 of the specified cover has been interpreted to apply to all covers. As presented in the Code, this requirement could be interpreted to apply to the cover measured to formed soffits only.

4) DLT 7.5(c) covers Section 7.5.2.1.

Datum 7.5(d)	Source	Label	Number
Location of bends and ends of reinforcement.	X		

DLT 7.5(d)	Tolerance Requirement TLLBE	1	2
C1	Bend or end of reinforcement at the discontinuous end of a member?	Y	N
A1	TLLBE = 2 in.		X
A2	TLLBE = 1/2 in.	X	
A3	DLT 7.5(e)	X	X

Comment: 1) DLT 7.5(d) covers Section 7.5.2.2.

Datum 7.5(e)	Source	Label	Number
Actual d, in. d on design drawings, in.	X		
Tolerance on d, in. Actual cover, in.	DLT 7.5(c)	Td	
Tolerance on minimum concrete cover, in.	DLT 7.5(c)	TMCC	
Actual location of bend or end of reinforcement.	X		
Location of bend or end of reinforcement on design drawings.	X		
Tolerance for longitudinal location of bends and ends of reinforcement, in.	DLT 7.5(d)	TLLBE	

DLT 7.5(e)	Tolerance Requirement Check	1	2	3	4
C1	Actual d = design d ± Td?	Y	Y	Y	N
C2	Actual cover = design cover - TMCC ?	Y	Y	N	I
C3	Actual location of bend <u>or</u> end = location on design drawings ± TLLBE?	Y	N	I	I
A1	Provisions = satisfied	X			
A2	Provisions ≠ satisfied		X	X	X
A3	DLT 7.5(f)	X	X	X	X

Comments:

1) The checks of this DLT are implied rather than specifically stated in the Code.

2) DLT 7.5(e) covers Section 7.5.2.

Datum 7.5(f)	Source	Label	Number
Statement of support conditions of reinforcement, prestressing tendons and ducts prior to concrete placement.	X		
Statement of Engineer's permission to weld crossing bars.	X		

DLT 7.5(f) Support and Welding Check		1	2	3
C1	Reinforcement, prestressing tendons and ducts adequately supported and secured against displacement?	Y	Y	N
C2	Welding of crossing bars for assembly of reinforcement permitted by the Engineer?	Y	N	I
A1	Provisions = satisfied	X		
A2	Provisions ≠ satisfied		X	X
A3	DLT Chapter 7-1	X	X	X

Comments:

1) No specific criteria are presented regarding adequate support nor for securing reinforcement material.

2) DLT 7.5(f) covers Sections 7.5.1 and 7.5.4.

Datum 7.5(g)	Source	Label	Number
Wire size of WWF.	X		
Span of slab.	X		
Configuration of WWF as installed (draped or not).	X		

DLT 7.5(g)		1	2	3
C1	WWF draped?	Y	Y	N
C2	WWF wire size $\leq$ W5 <u>or</u> D5 <u>and</u> used in a slab of span $\leq$ 10 ft?	Y	N	I
A1	DLT 7.5(h)	X		
A2	Provisions $\neq$ satisfied		X	
A3	DLT Chapter 7-1		X	
A4	DLT 7.5(b)			X

Comments:

1) If WWF is not draped, the provisions of 7.5.3 do not apply.

2) Draping of WWF complying with C2 is not a Code requirement, but an option.

3) DLT 7.5(g) partially covers Section 7.5.3.

Datum 7.5(h)	Source	Label	Number
Drape configuration.	X		
Conditions at support (securely anchored or continuous)	X		

DLT 7.5(h) WWF Drape Requirements		1	2	3
C1	Drape configuration = curved from a point near the the top of slab over the support to a point near the bottom of the slab at mid-span?	Y	Y	N
C2	WWF continuous over or securely anchored at support?	Y	N	I
A1	Provisions = satisfied	X		
A2	Provisions ≠ satisfied		X	X
A3	DLT Ch. 7-1	X	X	X

Comments:

1) Drape configuration requirements are not specific.

2) No specific requirements provided regarding anchorage of WWF.

3) DLT 7.5(h) covers Section 7.5.3.

Section 7.6 Spacing Limits for Reinforcement

Datum 7.6(a)	Source	Label	Number
Bar reinforcement.	X		
Bundled bar reinforcement.	X		
Prestressing tendon or duct	X		

DLT 7.6(a) Element Type 1		1	2	3	4	5
C1	Reinforcement element = bars?	Y	Y	N	N	ELSE
C2	Bar reinforcement = bundled bars?	Y	N	N	N	
C3	Reinforcement element = prestressing tendon or duct?	N	N	Y	N	
A1	DLT 7.6(b)		X			
A2	DLT 7.6(g)	X				
A3	DLT 7.6(i)			X		
A4	No provision; DLT Ch. 7-1				X	
A5	Logical Error					X

Comment: 1) DLT 7.6(a) is a switching DLT.

Datum 7.6(b)	Source	Label	Number
Type of structural element.	X		

DLT 7.6(b) Element Type 2		1	2	3	4
C1	Element = wall or slab other than concrete joist?	Y	N	N	E L
C2	Element = spirally or tied reinforced compression member?	N	Y	N	S E
A1	DLT 7.6(c)	X			
A2	DLT 7.6(d)		X		
A3	DLT 7.6(e)			X	
A4	Logical Error				X

Comment: 1) DLT 7.6(b) is a switching DLT.

Datum 7.6(c)	Source	Label	Number
Spacing of primary flexural reinforcement	X	s_p	
Thickness of wall or slab	X	t	

DLT 7.6(c) Spacing Requirement Check		1	2
C1	$s_p \leq$ minimum [3t, 18 in.]?	Y	N
A1	Provision = satisfied	X	
A2	Provision ≠ satisfied		X
A3	DLT 7.6(e)	X	X

Comments:

1) Section 13.4.2 specifies stricter spacing requirements for the case of two-way slabs at critical sections.

2) DLT 7.6(c) covers Section 7.6.5.

Datum 7.6(d)	Source	Label	Number
Clear distance between parallel or longitudinal bars, or between a contact lab splice and adjacent splices or bars, in.	X	s_{pc}	
Nominal diameter of bar, wire, or prestressing strand, in.; diameter derived from the equivalent total area of bundled bars.	X	d_b	

DLT 7.6(d)	Clear Distance Requirement 1	1	2
C1	$s_{pc} \geq$ minimum [1.5 d_b, 1.5 in.]?	Y	N
A1	Provision = satisfied	X	
A2	Provision $\neq$ satisfied		X
A3	DLT Ch 7-1	X	X

Comment: 1) DLT 7.6(d) covers Sections 7.6.3 and 7.6.4.

Datum 7.6 (e)	Source	Label	Number
Clear distance between bars in a layer.	X	CDBBL	
Bar diameter.	X	d_b	
Number of layers.	X		

DLT 7.6(e)	Clear Distance Requirement 2	1	2	3	4
C1	Clear distance between bars in a layer $\geq$ minimum $[d_b$, 1 in.$]$?	Y	Y	N	N
C2	Two or more layers present?	Y	N	Y	N
A1	Provision = satisfied	X	X		
A2	Provision $\neq$ satisfied			X	
A3	DLT 7.6(f)	X		X	
A4	DLT 7.6(a)		X		X

Comments:

1) See Section 3.3.3 of the Code for relevant requirements.

2) DLT 7.6(e) covers Section 7.6.1.

Datum 7.6(f)	Source	Label	Number
Vertical alignment of bars in layers.	X		
Clear distance between layers.	X		

DLT 7.6(f)	Clear Distance Between Layers Requirement	1	2	3
C1	Bars in upper layers directly above bars in the bottom layer?	Y	Y	N
C2	Clear distance between layers $\geq$ 1 in.?	Y	N	I
A1	Provision = satisfied	X		
A2	Provision $\neq$ satisfied		X	X
A3	DLT Chapter 7-1	X	X	X

Comments:

1) The Code is written in terms of horizontal layers.
2) C1 is an example of a condition which could require a subprogram in an automated Code.
3) DLT 7.6(f) covers Section 7.6.2.

Datum 7.6(g)	Source	Label	Number
Number of bars.	X		
Presence of bundled bars within ties or stirrups.	X		
Maximum bar size.	X		

DLT 7.6(g) Bundle Requirements 1		1	2	3	4
C1	Number of bars in bundle $\leq$ 4?	Y	Y	Y	N
C2	Bundled bars within ties or stirrups?	Y	Y	N	I
C3	Bar size $\leq$ #11?	Y	N	I	I
A1	Provision = satisfied	X			
A2	Provision $\neq$ satisfied		X	X	X
A3	DLT 7.6(h)	X	X	X	X

Comments:

1) Bundled bars ≡ groups of parallel reinforcing bars bundled in contact to act as a unit.

2) DLT 7.6(g) covers Sections 7.6.6.1, 7.6.6.2, and 7.6.6.3.

Datum 7.6(h)	Source	Label	Number
If bars are terminated within the span of flexural member.	X		
Stagger distance of termination points.	X		
Bar diameter.	X	d_b	

DLT 7.6(h)	Bundle Requirements 2	1	2	3	4
C1	Individual bars within a bundle terminated within the span of a flexural member?	Y	Y	N	E L S E
C2	Stagger of termination points $\geq$ 40 d_b?	Y	N		
A1	Provisions = satisfied	X			
A2	Provisions $\neq$ satisfied		X		
A3	DLT 7.6(a)	X	X	X	
A4	Logical Error				X

Comments:

1) It is assumed that d_b in C2 refers to the diameter of an individual bar in the bundle. See PCA Notes in ACI 318-77.

2) DLT 7.6(h) covers Section 7.6.6.4.

3) Provisions of Section 7.6.6.5 are covered in Section 7.7.

Datum 7.6(i)	Source	Label	Number
Reinforcing element: tendon or duct?	X		
Type of tendon: wire or strand.	X		
Diameter of wire or strand.	X	d_b	

DLT 7.6(i)	MCDEM Provision	1	2	3	4
C1	Element = pretensioning tendon?	Y	Y	N	ELSE
C2	Tendon = wire?	Y	N		
C3	Tendon = strand?	N	Y		
A1	MCDEM = 4 d_b	X			
A2	MCDEM = 3 d_b		X		
A3	DLT 7.6(j)	X	X		
A4	DLT 7.6(k)			X	
A5	Logical Error				X

Comments:

1) MCDEM = minimum clear distance between pretensioning tendons at end of a member.

2) See Section 3.3.3 of the Code for relevant requirements.

3) DLT 7.6(i) partially covers Section 7.6.7.1.

Datum 7.6(j)	Source	Label	Number
Clear distance between pretensioning tendons at the end of a member.	X	CDEM	
Minimum clear distance between pre-tensioning tendons at the end of a member.	DLT 7.6(i)	MCDEM	

DLT 7.6(j)	Tendon Requirement	1	2
C1	CDEM $\geq$ MCDEM?	Y	N
C2	Vertical spacing in middle portion of span < CDEM?	I	I
C3	Tendons bundled in middle of span?	I	I
A1	Provision = satisfied	X	
A2	Provision ≠ satisfied		X
A3	DLT Chapter 7-1	X	X

Comments:

1) The Code states that closer vertical spacing and bundling of strands may be permitted in the middle portion of a span. The responses to C2 and C3 therefore become immaterial to the outcome.

2) DLT 7.6(j) covers Section 7.6.7.1.

Datum 7.6(k)	Source	Label	Number
If post-tensioning ducts are bundled.	X		
If it has been shown that concrete can be satisfactorily placed.	X		
If provision is made to prevent tendons, when tensioned, from breaking through the duct.	X		

DLT 7.6(k)	Post-Tensioning Duct Requirement	1	2	3
C1	Post-tensioning ducts bundled?	Y	Y	N
C2	Provision made to prevent tendons from breaking through duct when tensioned <u>and</u> concrete can be satisfactorily placed?	Y	N	I
A1	Provision = satisfied	X		
A2	Provision ≠ satisfied		X	
A3	No provision			X
A4	DLT Ch. 7-1	X	X	X

Comment: 1) DLT 7.6(k) covers Section 7.6.7.2.

Section 7.7 Concrete Protection for Reinforcement

Datum 7.7(a)	Source	Label	Number
If material is non-prestressed, reinforcement in cast-in-place concrete.	X		
If material is non-prestressed, reinforcement in precast concrete manufactured under plant control conditions.	X		
If material is prestressed or non-prestressed, reinforcement or end fittings in prestressed concrete.	X		

DLT 7.7(a)	Category	1	2	3	4	5
C1	Non-prestressed reinforcement in cast-in-place concrete?	Y	N	N	N	E
C2	Non-prestressed reinforcement in precast concrete manufactured under plant control conditions?	N	Y	N	N	L S
C3	Prestressed or non-prestressed reinforcement, or ducts, or end fittings in prestressed concrete?	N	N	Y	N	E
A1	DLT 7.7(b)	X				
A2	DLT 7.7(e)		X			
A3	DLT 7.7(i)			X		
A4	No provision: DLT Ch. 7-1				X	
A5	Logical Error					X

Comment: 1) DLT 7.7(a) is a switching DLT.

Datum 7.7(b)	Source	Label	Number
If concrete is cast against and permanently exposed to earth.	X		
If reinforcement is bundled bars.	X		
If (formed) concrete is exposed to earth or weather.	X		

	DLT 7.7(b) Cast-in-Place Requirements 1	1	2	3	4	5
C1	Concrete Cast against and permanently exposed to earth?	Y	N	N	N	E
						L
C2	Reinforcement = bundled bars?	I	Y	N	N	S
C3	Concrete (formed) exposed to earth or weather?	N	I	Y	N	E
A1	MCC = 3 in.	X				
A2	MCC = minimum [Equivalent diameter of bundle, 2 in.]		X			
A3	DLT 7.7(c)			X		
A4	DLT 7.7(d)				X	
A5	Logical Error					X
A6	DLT 7.7(n)	X	X			

Comments:

1) C1 and C3, in a strict sense, are dependent conditions because if concrete is cast against and permanently exposed to earth (Y to C1), the response to C3 must be Y. It is assumed here that for purposes of responding to C3, the Code is referring to formed concrete which may or may not be exposed to earth.

2) It is assumed that a unit of bundled bars shall be treated as a single bar derived from the equivalent total area where spacing limitations and minimum concrete cover are based on bar diameter d_b.

3) DLT 7.7(b) partially covers Sections 7.7.1 and 7.6.6.5.

Datum 7.7(c)	Source	Label	Number
Reinforcement Size	X		

DLT 7.7(c)	Cast-in-Place Requirements 2	1	2	3	4
C1	Size = #5 bar, W31 or D31 wire or smaller?	Y	N	N	ELSE
C2	Size = #6 through #18 bars?	N	Y	N	
A1	MCC = 1.5 in.	X			
A2	MCC = 2.0 in.		X		
A3	DLT 7.7(n)	X	X		
A4	No Provision: DLT Chapter 7-1			X	
A5	Logical Error				X

Comment:

1) DLT 7.7(c) partially covers Section 7.7.1.

Datum 7.7(d)	Source	Label	Number
Member type.	X		
Reinforcement type.	X		
Reinforcement size	X		

DLT 7.7(d) Cast-in-Place Requirements 3		1	2	3	4	5	6	7
C1	Member type = slab, wall <u>or</u> joist?	Y	Y	N	N	N	N	
C2	Bar size > #11?	Y	N					E
C3	Primary reinforcement, ties, stirrups, <u>or</u> spirals in beams or columns?	N	N	Y	N	N	N	L
C4	Member type = shell <u>or</u> folded plate?	N	N	N	Y	Y	N	S
C5	Reinforcement = #5 bar, W31 or D31 wire, <u>or</u> smaller?				N	Y		E
A1	MCC = 1.5 in.	X		X				
A2	MCC = 0.75 in.		X		X			
A3	MCC = 0.50 in.					X		
A4	No provision: DLT Ch. 7-1						X	
A5	DLT 7.7(n)	X	X	X	X	X		
A6	Logical Error							X

Comment: 1) DLT 7.7(d) partially covers Section 7.7.1.

Datum 7.7(e)	Source	Label	Number
If bars are bundled.	X		

DLT 7.7(e)	Precast Requirements 1	1	2
C1	Reinforcement = bundled bars?	Y	N
A1	MCC = minimum [equivalent diameter of bundle, 2 in.]	X	
A2	DLT 7.7(f)		X
A3	DLT 7.7(h)	X	

Comments:

1) DLT 7.7(e) partially covers Section 7.7.2.

2) See Comment 2, DLT 7.7(b).

Datum 7.7(f)	Source	Label	Number
If concrete is exposed to earth or weather.	X		
If member is a wall panel.	X		
Reinforcement size.	X		

DLT 7.7(f)	Precast Requirements 2	1	2	3	4	5	6	7
C1	Concrete exposed to earth or weather?	Y	Y	Y	Y	Y	N	E
C2	Member type = wall panel?	Y	Y	N	N	N		L
C3	Bar size > #11?	Y	N	Y	N	N		S
C4	Bar size $\geq$ #6?			Y	Y	N		E
C5	Reinforcement = #5 bar, W31 or D31 wire, <u>or</u> smaller?			N	N	Y		
A1	MCC = 2 in.			X				
A2	MCC = 1.5 in.	X			X			
A3	MCC = 1.25 in.					X		
A4	MCC = 0.75 in.		X					
A5	DLT 7.7(h)	X	X	X	X	X		
A6	DLT 7.7(g)						X	
A7	Logical Error							X

Comment: 1) DLT 7.7(f) partially covers Section 7.7.2.

Datum 7.7(g)	Source	Label	Number
Member type.	X		
Reinforcement size.	X		
Reinforcement type.	X		

DLT 7.7(g)	Precast Requirement 3	1	2	3	4	5	6	7	8
C1	Member type = slab, wall, <u>or</u> joist?	Y	Y	N	N	N	N	N	
C2	Bar size > #11?	Y	N						E
C3	Member type = beam <u>or</u> column?	N	N	Y	Y	N	N	N	L
C4	Primary reinforcement?			Y	N				S
C5	Reinforcement = ties, stirrups, <u>or</u> spirals?			N	Y				E
C6	Member type = shells or folded plate members?	N	N	N	N	Y	Y	N	
C7	Reinforcement = #5 bar, W31 or D31 wire, or smaller?					Y	N		
A1	MCC = 1.25 in.	X							
A2	MCC = 0.625 in.		X				X		
A3	MCC = 0.375 in.				X	X			
A4	MCC = minimum [max(d_b, 5/8"), 1½ in.]								
A5	No provision: DLT Ch. 7-1							X	
A6	DLT 7.7(h)	X	X	X	X	X	X		
A7	Logical Error								X

Comment: 1) DLT 7.7(g) partially covers Section 7.7.2.

Datum 7.7(h)	Source	Label	Number
If the reinforcement = non-prestressed in a prestressed member manufactured under plant control conditions?	X		
Minimum concrete cover.	DLT 7.7 (e,f,g)	MCC	

DLT 7.7(h)	Precast Requirement 4	1	2
C1	Reinforcement = non-prestressed in a prestressed member manufactured under plant control conditions?	Y	N
A1	MCC = MCC	X	X
A2	DLT 7.7(m)	X	
A3	DLT 7.7(n)		X

Comments:

1) This DLT represents Section 7.7.3.3 of the Code and is located here for convenience.

2) A positive response to C1 indicates that the minimum concrete cover for non-prestressed reinforcement in a prestressed member manufacturered under plant control conditions is the same as for precast concrete members.

3) In A1, MCC = MCC indicates that the value of MCC developed in previous DLT's is not altered and is the datum output of this DLT.

Datum 7.7(i)	Source	Label	Number
If the reinforcement = non-prestressed in a prestressed member, manufacture under plant control conditions.	X		

DLT 7.7(i)	Requirements PS 1	1	2
C1	Reinforcement = non-prestressed in a prestressed member, manufacture under plant control conditions?	Y	N
A1	DLT 7.7(e)	X	
A2	DLT 7.7(j)		X

Comments:

1) The way in which the first sentence in Section 7.7.3.1 of the Code is phrased could lead one to believe that the requirements of 7.7.3.1 apply to non-prestressed reinforcement as well as prestressed. However, based on the context of Section 7.7, it is assumed here that the intent of the Code is for the requirement to apply to non-prestressed reinforcement which is in prestressed concrete members.

2) DLT 7.7(i) is a switching DLT.

Datum 7.7(j)	Source	Label	Number
If concrete is cast against and permanently exposed to earth.	X		
If (formed) concrete is exposed to earth or weather.	X		
If bars are bundled.	X		

DLT 7.7(j) Requirements PS 2		1	2	3	4	5
C1	Concrete cast against and permanently exposed to earth?	Y	N	N	N	E
C2	(Formed) concrete exposed to earth or weather?	N	I	Y	N	L S
C3	Reinforcement = bundled bars?	I	Y	N	N	E
A1	MCC = 3 in.	X				
A2	MCC = minimum [equivalent diameter of bundle, 2 in.]		X			
A3	DLT 7.7(k)			X		
A4	DLT 7.7(l)				X	
A5	DLT 7.7(m)	X	X			
A6	Logical Error					X

Comments:

1) See comment to DLT 7.7(b)

2) DLT 7.7(j) partially covers Sections 7.7.3.1 and 7.7.4.

Datum 7.7(k)	Source	Label	Number
Member type.	X		

DLT 7.7(k) Requirements PS 3		1	2
C1	Member = panel, slab, or joist?	Y	N
A1	MCC = 1.0 in.	X	
A2	MCC = 1.5 in.		X
A3	DLT 7.7(m)	X	X

Comment: 1) DLT 7.7(k) partially covers Section 7.7.3.1.

Datum 7.7(ℓ)	Source	Label	Number
Member type.	X		
Reinforcement type.	X		
Reinforcement size.	X		

	DLT 7.7(ℓ) Requirements PS 4	1	2	3	4	5	6	7
C1	Member = slab, wall, <u>or</u> joist?	Y	N	N	N	N	N	
C2	Member = beam or column?	N	Y	Y	N	N	N	E
C3	Reinforcement = primary?		Y	N				L
C4	Reinforcement = ties, stirrups, <u>or</u> spirals?		N	Y				S
C5	Member = shell <u>or</u> folded plate?	N	N	N	Y	Y	N	E
C6	Reinforcement = #5 bar, W31 <u>or</u> D31 wire, <u>or</u> smaller?				Y	N		
A1	MCC = 1.5 in.		X					
A2	MCC = 1.0 in.			X				
A3	MCC = 0.75 in.	X						
A4	MCC = 0.375 in.				X			
A5	MCC = maximum [d_b, 0.75 in.]					X		
A6	No provision: DLT Chapter 7-1						X	
A7	DLT 7.7(m)	X	X	X	X	X		
A8	Logical Error							X

Comment: 1) DLT 7.7(ℓ) partially covers Section 7.7.3.1.

Datum 7.7(m)	Source	Label	Number
Exposure to earth, weather, or corrosive environment.	X		
Square root of compressive strength of concrete, psi	X	$\sqrt{f'_c}$	
Extreme fiber stress in tension in precompressed tensile zone, psi, after allowance for all prestress loss.	X	f_{ct}	
Minimum concrete cover.	DLT 7.7 (j,k,l)	MCC	

DLT 7.7(m) Requirements PS 5		1	2	3
C1	Member exposed to earth, weather, <u>or</u> corrosive environment?	Y	Y	N
C2	$f_{ct} > 6\sqrt{f'_c}$?	Y	N	I
A1	MCC = 1.5 MCC	X		
A2	MCC = MCC		X	X
A3	DLT 7.5(n)	X	X	X

Comments:

1) An apparent contradiction exists in the Code between Sections 7.7.3.2 and 18.4.2(b). The requirement of 18.4.2(b) is that f_{ct} <u>shall not</u> exceed a specified value. In Section 7.7.3.2 a provision is supplied for the event that f_{ct} exceeds the maximum value.

2) Exposure to earth or weather for specific classes of prestressed concrete was established in DLT 7.7(j). It is necessary to reestablish it here because of the additional concern of corrosive environment introduced in Section 7.7.3.2 and the generality of 7.7.3.2.

3) DLT 7.7(m) covers Section 7.7.3.2.

Datum 7.7(n)	Source	Label	Number
MCC for fire protection specified in the general building code.	X	MCCFP	
Minimum concrete cover.	DLT 7.7 (b,c,d,h,m)	MCC	

DLT 7.7(n) Requirements PS 6		1	2
C1	MCCFP specified in the general building code > MCC?	Y	N
A1	MCC = MCCFP	X	
A2	MCC = MCC		X
A3	DLT 7.7(o)	X	X

Comment: 1) DLT 7.7(n) covers Section 7.7.7.

Datum DLT 7.7(o)	Source	Label	Number
Exposure to corrosive or other severe environment.	X		
If concrete protection suitably increased.	X		
Consideration of density and nonporosity of protecting concrete.	X		
Provision of other protection.	X		

	DLT 7.7(o) Corrosive Environment 1	1	2	3	4	5
C1	Member exposed to corrosive or other severe environment?	N	Y	Y	Y	E
C2	Concrete protection suitably increased <u>and</u> denseness and nonporosity of protecting concrete considered?		Y	N	N	L S
C3	Other protection provided?		I	Y	N	E
A1	Provisions = satisfied		X	X		
A2	Provisions ≠ satisfied				X	
A3	DLT 7.7(o)	X	X	X	X	
A4	Logical Error					X

Comments:

1) Section 7.7.5 is taken to be a general provision which applies to all forms of concrete covered in Section 7.7. Hence, a prestressed concrete member must be checked here also.

2) In C2, the phrase "concrete protection suitably increased" is understood to mean increased over the minimum concrete cover (MCC) values provided in 7.7.1, 7.7.2, and 7.7.3.

3) The requirements expressed in this DLT are qualitative and may not be amenable to future automation.

4) DLT 7.7(o) covers Section 7.7.5.

Datum 7.7(p)	Source	Label	Number
Actual concrete cover.	X		
Minimum concrete cover.	DLT 7.7(n)	MCC	

DLT 7.7(p) MCC Requirement Check		1	2
C1	Actual concrete cover $\geq$ MCC?	Y	N
A1	Provision = satisfied	X	
A2	Provision $\neq$ satisfied		X
A3	DLT 7.7(q)	X	X

Comment: 1) DLT 7.7(p) covers Sections 7.7.1, 7.7.2, and 7.7.3.

Datum 7.7(q)	Source	Label	Number
Presence of exposed reinforcement, insert, or plates intended for bonding with future extensions.	X		
Presence of corrosion protection.	X		

DLT 7.7(q) Corrosion Protection Requirement Check		1	2
C1	Exposed reinforcement, insert, or plate intended for bonding with future extensions protected against corrosion?	Y	N
A1	Provision = satisfied	X	
A2	Provision ≠ satisfied		X
A3	DLT Chapter 7-1	X	X

Comments:

1) C1 (and Section 7.7.6), as written, implies that all exposed reinforcements, inserts, or plates are intended for bonding with future extensions. Another interpretation could be that if such items are exposed, but not intended for bonding, then no protection is required.

2) DLT 7.7(q) covers Section 7.7.6.

Section 7.8 Special Reinforcing Details for Columns

Datum 7.8(a)	Source	Label	Number
Column configuration.	X		

DLT 7.8(a) Column Configuration		1	2	3	4
C1	Column face offset?	Y	N	N	ELSE
C2	Column with structural steel core.	N	Y	N	
A1	DLT 7.8(b)	X			
A2	DLT 7.8(h)		X		
A3	No provisions: DLT Ch. 7-1			X	
A4	Logical Error				X

Datum 7.8(b)	Source	Label	Number
Column face offset.	X		
If longitudinal bars are offset bent.	X		

DLT 7.8(b)	Offset Bending Requirements Check	1	2	3
C1	Column face offset $\geq$ 3 in.?	Y	N	I
C2	Longitudinal bars offset bent?	Y	Y	N
A1	Provision = satisfied		X	X
A2	Provision $\neq$ satisfied	X		
A3	DLT 7.8(c)			X
A4	DLT 7.8(d)	X	X	

Comments:

1) Rule 3 represents an ambiguity. The Code is not specific for the case of bars not offset bent where the column face is offset less than 3 in. The implication is that either offset bending <u>or</u> the use of dowels per 7.8.1.5 is permitted for offsets from 0 through 3 in.

2) DLT 7.8(b) partially covers Section 7.8.1.5.

Datum 7.8(c)	Source	Label	Number
Presence of dowels, lap spliced with the longitudinal bars adjacent to column faces.	X		
Conformance of lap splices with requirements of Section 12.18	X (Sec. 12.18)		

DLT 7.8(c)	Bar Splicing Requirement Check	1	2	3	4
C1	Separate dowels, lap spliced with the longitudinal bars adjacent to column faces provided?	Y	Y	N	ELSE
C2	Lap splices in conformance with Section 12.18?	Y	N		
A1	Provisions = satisfied	X			
A2	Provisions ≠ satisfied		X	X	
A3	DLT Ch. 7-1	X	X	X	
A4	Logical Error				X

Comment: 1) DLT 7.8(c) partially covers Section 7.8.1.5.

Datum 7.8(d)	Source	Label	Number
Slope of inclined portion.	X		
Parallelism of bar above and below offset to column axis.	X		

DLT 7.8(d)	Location and Geometry Check	1	2	3
C1	Slope of inclined portion $\leq$ 1 in 6?	Y	N	N
C2	Portions of bar above and below the offset parallel to column axis?	Y	N	I
A1	Provision = satisfied	X		
A2	Provision $\neq$ satisfied		X	X
A3	DLT 7.8(e)	X	X	X

Comment: 1) DLT 7.8(d) covers Sections 7.8.1.1 and 7.8.1.2.

Datum 7.8(e)	Source	Label	Number
Design capacity of horizontal supports.	X		

DLT 7.8(e)	Support Requirements 1	1	2
C1	Horizontal support designed to resist (at least) 1½ times the horizontal component of the computed force in the inclined portion of the bar?	Y	N
A1	Provision = satisfied	X	
A2	Provision ≠ satisfied		X
A3	DLT 7.8(f)	X	X

Comments:

1) Strictly interpreted, Section 7.8.1.3 stipulates that the horizontal support should be designed to resist <u>exactly</u> 1½ times the horizontal component of the computed in the inclined portion of the offset bar.

2) It is assumed here that the interest is to provide for <u>at least</u> 1½ times the horizontal component.

3) DLT 7.8(e) partially covers Section 7.8.1.3.

Datum 7.8(f)	Source	Label	Number
Method of horizontal support.	X		
Location of lateral tie or spiral from point of bend.	X		

	DLT 7.8(f) Support Requirements 2	1	2	3	4	5
C1	Horizontal support provided by lateral ties <u>or</u> spirals?	Y	Y	N	N	E
						L
C2	Location of lateral tie or spiral $\leq$ 6 in. from point of bend?	Y	N			S
C3	Horizontal support provided by parts of floor construction?	N	N	Y	N	E
A1	Provisions = satisfied	X		X		
A2	Provisions $\neq$ satisfied		X		X	
A3	DLT 7.8(g)	X	X	X	X	
A4	Logical Error					X

Comment: 1) DLT 7.8(f) partially covers Section 7.8.1.3.

Datum 7.8(g)	Source	Label	Number
Time of bending of offset bars.	X		

DLT 7.8(g) Time of Bending Check		1	2
C1	Offset bars bent before placement in forms?	Y	N
A1	Provision = satisfied	X	
A2	Provision ≠ satisfied		X
A3	DLT Chapter 7-1	X	X

Comments:

1) See Section 7.3.

2) DLT 7.8(g) covers Section 7.8.1.4.

Datum 7.8(h)	Source	Label	Number
Ends of structural steel core accurately finished to bear at end bearing splice.	X		
Provision for alignment of cores.	X		

	DLT 7.8(h) End Bearing Splice Requirement 1	1	2	3
C1	End of structural steel core accurately finished to bear at end bearing splice?	Y	Y	N
C2	Positive provision for alignment of one core above the other in concentric contact?	Y	N	I
A1	Provision = satisfied	X		
A2	Provision ≠ satisfied		X	X
A3	DLT 7.8(i)	X	X	X

Comment: 1) DLT 7.8(h) covers Section 7.8.2.1.

Datum 7.8(i)	Source	Label	Number
Effectiveness of bearing to transfer compressive stress in the steel core.	X		

DLT 7.8(i)	End Bearing Splice Requirement 2	1	2
C1	At end bearing splice, is bearing considered effective to transfer 50% or less of the total compressive stress in the steel core?	Y	N
A1	Provision = satisfied	X	
A2	Provision ≠ satisfied		X
A3	DLT 7.8(j)	X	X

Comment:

1) DLT 7.8(i) covers Section 7.8.2.2.

Datum 7.8(j)	Source	Label	Number
Base of structural steel section designed to transfer the total load from the entire composite member to the footing.	X		
Design of base to transfer the load from the steel core only.	X		
Sufficient concrete section available to transfer the portion of the total load carried by the reinforced concrete section to the footing by compression in the concrete and by reinforcement.	X		

	DLT 7.8(j) Column Base Requirement 1	1	2	3	4
C1	Is the base of the structural steel section designed to transfer the total load from the entire composite member to the footing?	Y	N	N	E L
C2	Base designed to transfer the load from the steel core only and sufficient concrete section available to transfer the portion of the total load carried by the reinforced concrete section to the footing by compression in the concrete and by reinforcement.	N	Y	N	S E
A1	Provision = satisfied	X	X		
A2	Provision ≠ satisfied			X	
A3	DLT Ch. 7-1	X		X	
A4	DLT 7.8(k)		X		
A5	Logical Error				X

Comment: 1) DLT 7.8(j) covers Section 7.8.2.4.

Datum 7.8(k)	Source	Label	Number
If the transfer of forces carried by the reinforced concrete section to the footing is in accordance with Section 15.8.	X (Section 15.8)		

DLT 7.8(k)		1	2
C1	Transfer of forces in the reinforced concrete section in accordance with Section 15.8?	Y	N
A1	Provision = satisfied	X	
A2	Provision ≠ satisfied		X
A3	DLT Ch. 7-1	X	X

Comments:

1) The Code is not clear at this point. Section 7.8.2.3 apparently applies to the entire composite column, but Section 15.8 to which it refers provides for reinforced columns.

2) It was assumed that the intent was for Section 7.8.2.3 to apply to the concrete portion of the column only.

3) DLT 7.8(k) covers Section 7.8.2.3.

Section 7.9 Connections

Datum 7.9(a)	Source	Label	Number
If connection is of principal framing element.	X		
If enclosure is provided for splices of continuing reinforcement and for end anchorage of reinforcement terminating in connections of principal framing elements.	X		

DLT 7.9(a)	Connection Requirements Check	1	2	3	4
C1	Connection of principal framing elements?	Y	Y	N	ELSE
C2	Enclosure provided for splices of continuing reinforcement and for end anchorage of reinforcement terminating in such connections?	Y	N		
C3	Enclosure = external concrete, internal closed ties, spirals, or stirrups?	I			
A1	Provisions = satisfied	X			
A2	Provisions ≠ satisfied		X		
A3	No provision			X	
A4	DLT Ch. 7-1	X	X	X	
A5	Logical Error				X

Comments:

1) The provisions of Section 7.9.2 were taken to apply to connections of principal framing members considered in Section 7.9.1. This means that no provisions for enclosure are required by the code at other connections.

2) The use of the word "may" in Section 7.9.2 has the effect of making the response to C1 in Rule 1 "immaterial" (I).

3) DLT 7.9(a) covers Sections 7.9.1 and 7.9.2.

Section 7.10 Lateral Reinforcement for Compression Members

Datum 7.10(a)	Source	Label	Number
Waiver of provisions of Sections 7.10, 10.14, and 18.11.	X		
Verification of adequate strength and feasibility of construction by test and analysis.	X		

DLT 7.10(a) Waiver of Requirements		1	2	3
C1	Provisions of Sections 7.10, 10.14 & 18.11 waived?	Y	Y	N
C2	Do tests and structural analysis show adequate strength and feasibility of construction?	Y	N	I
A1	Provision = satisfied	X		
A2	Provision ≠ satisfied		X	
A3	DLT 7.10(b)		X	X
A4	DLT Ch. 7-1	X		

Comment: 1) DLT 7.10(a) covers Section 7.10.3.

Datum 7.10(b)	Source	Label	Number
If lateral reinforcement is for a composite member.	X		
If lateral reinforcement is spirals for prestressing tendons.	X		
If lateral reinforcement is ties for prestressing tendons.	X		

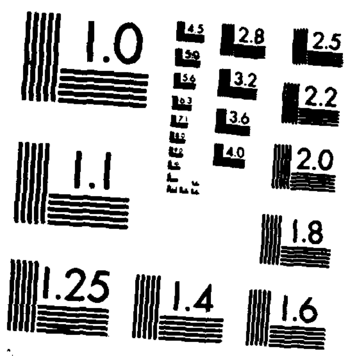
DLT 7.10(b)	Application of Lateral Reinforcement	1	2	3	4	5
C1	Lateral reinforcement for composite compression member?	Y	N	N	N	ELSE
C2	Lateral reinforcement = spirals for prestressing tendons?	N	Y	N	N	
C3	Lateral reinforcement = ties for prestressing tendons.	N	N	Y	N	
A1	DLT Chapter 10 (Section 10.14)	X				
A2	DLT 7.10(e)		X			
A3	DLT Chapter 18 (Section 18.11)			X		
A4	DLT 7.10(d)				X	
A5	Logical Error					X

Comment:

1) DLT 7.10(b) covers Section 7.10.2.

AD-A173 663 COMPUTER-AIDED STRUCTURAL ENGINEERING (CASE) PROJECT DECISION LOGIC TABL (U) ATKINSON-NOLAND & ASSOCIATES INC BOULDER CO J L NOLAND JUL 86 ATC-TR-86-5-VOL-1 2/6

UNCLASSIFIED DACW39-82-M-3741 F/G 9/2 NL



ICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Datum 7.10(c)	Source	Label	Number
Requirement for shear or torsion reinforcement.	X		
If lateral reinforcement is in conformance with Chapter 11.	X (Ch. 11)		

DLT 7.10(c)		1	2	3	4
C1	Shear or torsion reinforcement required?	Y	Y	N	ELSE
C2	Lateral reinforcement in conformance with the provisions of Chapter 11?	Y	N		
A1	Provision = satisfied	X			
A2	Provision ≠ satisfied		X		
A3	DLT 7.10(d)	X		X	
A4	DLT Chapter 7-1		X		
A5	Logical Error				X

Comments:

1) This DLT was written such that no further processing is done if the provisions of Chapter 11 have not been satisfied if shear or torsion reinforcement is required.

2) DLT 7.10(c) covers Section 7.10.1.

Datum 7.10(d)	Source	Label	Number
Spiral Lateral Reinforcement	X		
Tie Lateral Reinforcement	X		

DLT 7.10(d)	Type of Lateral Reinforcement	1	2	3	4
C1	Lateral reinforcement = spirals?	Y	N	N	ELSE
C2	Lateral reinforcement = ties?	N	Y	N	
A1	DLT 7.10(e)	X			
A2	DLT 7.10(o)		X		
A3	No provision: DLT Chapter 7-1			X	
A4	Logical Error				X

Comment:

1) DLT 7.10(d) is a switching DLT.

Datum 7.10(e)	Source	Label	Number
Gross area of section, sq in.	X	A_g	
Area of core of spirally reinforced compression member measured to outside diameter of spiral, sq in.	X	A_c	
Specified concrete strength, psi	X	f'_c	
Specified yield strength of spiral reinforcement	X	f_y	

	DLT 7.10(e) Minimum Ratio Requirement Check	1	2	3
C1	$\rho_s \geq 0.45 \left(\frac{A_g}{A_c} - 1 \right) \frac{f'_c}{f_y}$?	Y	Y	N
C2	$f_y \leq 60{,}000$ psi?	Y	N	I
A1	Provision = satisfied	X		
A2	Provision ≠ satisfied		X	X
A3	DLT 7.10(f)	X	X	X

Comment: 1) DLT 7.10(e) covers Sections 10.9.3 and 7.10.4.

Datum 7.10(f)	Source	Label	Number
Continuity of wire or bar.	X		
Regularity of spacing.	X		
Spacing of dimension.	X		

	DLT 7.10(f) Spacing Requirement Check	1	2	3	4
C1	Spirals consist of continuous wire <u>or</u> bar?	Y	Y	Y	N
C2	Spacing = even?	Y	Y	N	I
C3	1 in. $\leq$ spacing $\leq$ 3 in?	Y	N	I	I
A1	Provision = satisfied	X			
A2	Provision $\neq$ satisfied		X	X	X
A3	DLT 7.10(g)	X	X	X	X

Comment:

1) DLT 7.10(f) covers Sections 7.10.4.1 and 7.10.4.3.

Datum 7.10(g)	Source	Label	Number
Capability of spirals of given size and assembly to be handled and placed accurately.	X		
Presence of vertical spacers to hold spirals in place and true to line.	X		

DLT 7.10(g) Assembly and Installation Requirements Check		1	2	3	4
C1	Spirals made of bar or wire of such size and so assembled to permit handling and placing without distortion from designed dimension?	Y	Y	N	N
C2	Spirals held firmly in place and true to line by vertical spacers?	Y	N	Y	N
A1	Provisions = satisfied	X			
A2	Provisions ≠ satisfied		X	X	X
A3	DLT 7.10(h)	X		X	
A4	DLT 7.10(j)		X		X

Comments:

1) Bar size and assembly required to satisfy Section 7.10.4.1 are not specified in the Code. Judgement or other information is required to regard to C1.

2) The implication of C2 (Section 7.10.4.9) is that vertical spacers will hold spirals firmly in place and true to line.

3) DLT 7.10(g) covers Sections 7.10.4.1 and 7.10.4.9.

Datum 7.10(h)	Source	Label	Number
Diameter of spiral bar or wire.	X	d_b	
Diameter of spiral	X	d_{sp}	

DLT 7.10(h)	Spacer Requirements	1	2	3	4	5	6
C1	d_b (spiral wire or bar) $\geq$ 5/8 in.?	Y	Y	N	N	N	E
C2	d_{sp} (spiral diameter) < 20 in.?			N	N	Y	L
C3	d_{sp} (spiral diameter) > 30 in.?			Y	N	N	S
C4	d_{sp} (spiral diameter) > 24 in.?	Y	N				
A1	Minimum number of spacers required (MNSPR) = 2					X	
A2	MNSPR = 3		X		X		
A3	MNSPR = 4	X		X			
A4	DLT 7.10(i)	X	X	X	X	X	
A5	Logical Error						X

Comments:

1) The Code does not fully describe the relationship between spiral geometry and number of spirals. It is assumed that the intent is for the minimum number of spirals to apply to the circumference.

2) DLT 7.10(h) covers Section 7.10.4.10 and partially covers Section 7.10.4.11.

Datum 7.10(i)	Source	Label	Number
Minimum number of spacers required.	DLT 7.10(h)	MNSPR	
Number of spacers used.			

DLT 7.10(i)	Spacer Requirement Check	1	2
C1	Number of spacers used $\geq$ MNSPR?	Y	N
A1	Provision = satisfied	X	
A2	Provision $\neq$ satisfied		X
A3	DLT 7.10(j)	X	X

Comment: 1) DLT 7.10(i) covers Section 7.10.4.11.

Datum 7.10(j)	Source	Label	Number
Anchorage configuration.	X		
Lap splice configuration.	X		
Welded splice.	X		

DLT 7.10(j)	Anchorages and Splices Check	1	2	3	4	5	6
C1	Anchorage = $1\frac{1}{2}$ extra turns of bar or wire at each end of spiral unit?	Y	Y	Y	N	N	E L
C2	Splice = lap splice with lap = maximum[48 d_b, 12 in.]?	Y	N	N	Y	N	S
C3	Splice = welded?						E
A1	Provisions = satisfied	X	X				
A2	Provisions ≠ satisfied			X	X	X	
A3	DLT 7.10(k)	X	X	X	X	X	
A4	Logical Error						X

Comments:

1) C1 (Section 7.10.4.4) states that proper anchorage is obtained by exactly $1\frac{1}{2}$ extra turns of bar or wire. It is possible that this should be a minimum.

2) DLT 7.10(j) covers Sections 7.10.4.4 and 7.10.4.5.

Datum 7.10(k)	Source	Label	Number
Presence of capital	X		

DLT 7.10(k)		1	2
C1	Spiral in a column with a capital?	Y	N
A1	Spiral extension (SE) = extending from top of footing <u>or</u> slab in any story to level of lowest horizontal reinforcement in members supported above.		X
A2	SE = extending to a level at which the diameter <u>or</u> width of capital is 2 times that of the column.	X	
A3	DLT 7.10(ℓ)	X	X

Comments:

1) It is assumed here that Sections 7.10.4.6 (A1) and 7.10.4.8 (A2) are exclusive, i.e., either one or the other applies.

2) DLT 7.10(k) partially covers Section 7.10.4.8 and Section 7.10.4.6.

Datum 7.10(ℓ)	Source	Label	Number
Actual extension of spiral.	X		
Spiral extension required.	DLT 7.10(k)	SE	

DLT 7.10(ℓ) Spiral Length Check		1	2
C1	Actual spiral extension $\geq$ SE?	Y	N
A1	Provision = satisfied	X	
A2	Provision $\neq$ satisfied		X
A3	DLT 7.10(m)	X	X

Comment: 1) DLT 7.10(ℓ) covers Sections 7.10.4.8 and 7.10.4.6.

Datum 7.10(m)	Source	Label	Number
Beams on brackets framing into the column.	X		
Presence and extension of ties above the termination of the spiral.	X		

DLT 7.10(m) Additional Tie Requirement Check		1	2	3
C1	Beams or brackets frame into <u>all</u> sides of the columns?	Y	N	N
C2	Ties provided which extend above the termination of the spiral to the bottom of the slab or drop panel?	I	Y	N
A1	Provision = satisfied	X	X	
A2	Provision ≠ satisfied			X
A3	DLT 7.10(n)	X	X	X

Comment: 1) DLT 7.10(m) covers Section 7.10.4.7.

Datum 7.10(n)	Source	Label	Number
If cast-in-place construction	X		
Diameter of bar or wire used in spiral.	X		

DLT 7.10(n)		1	2	3
C1	Cast-in-place construction?	Y	Y	N
C2	Diameter of bar or wire used in spiral $\geq$ 3/8 in.?	Y	N	I
A1	Provision = satisfied	X		X
A2	Provision $\neq$ satisfied		X	
A3	DLT Chapter 7-1	X	X	X

Comments:

1) The phrase in the Code from Section 7.10.4.2 "size of spiral" was taken to mean diameter of bar or wire used in the spiral in C2.

2) DLT 7.10(n) covers Section 7.10.4.2.

Datum 7.10(o)	Source	Label	Number
Presence of lateral tie reinforcement for all non-prestressed bars.	X		

DLT 7.10(o)	Ties-General Requirement Check	1	2
C1	All non-prestressed bars in compression members enclosed by lateral ties?	Y	N
A1	Provision = satisfied	X	
A2	Provision ≠ satisfied		X
A3	DLT 7.10(p)	X	
A4	DLT Chapter 7-1		X

Comments:

1) The phraseology of C1 (Section 7.10.5.1) is not consistent with the introductory sentence to Section 7.10.5 nor Section 7.10.1. It could be interpreted to be a requirement that only lateral ties are permitted.

2) DLT 7.10(o) partially covers Section 7.10.5.1.

Datum 7.10(p)	Source	Label	Number
Longitudinal bar size.	X		
Presence of bundled bars.	X		

DLT 7.10(p)	Minimum Tie Size	1	2	3
C1	Longitudinal bar size > #10?	Y	N	N
C2	Longitudinal bars bundled?	I	Y	N
A1	Minimum tie size (MTS) = #3			X
A2	MTS = #4	X	X	
A3	DLT 7.10(q)	X	X	X

Comments:

1) The term "size" refers to the diameter of wire or bar, not to lateral dimensions.

2) DLT 7.10(p) partially covers Section 7.10.5.1.

Datum 7.10(q)	Source	Label	Number
Diameter of bar <u>or</u> wire used for tie.	X		
Equivalent area of welded wire fabric.	X		
Minimum tie size.	DLT 7.10(p)	MTS	

DLT 7.10(q) Tie Size Requirement Check		1	2	3	4
C1	Tie size provided ≥ MTS?	Y	N	N	E L S E
C2	Deformed wire <u>or</u> welded wire fabric equivalent in area to MTS used?	N	Y	N	
A1	Provisions = satisfied	X	X		
A2	Provisions ≠ satisfied			X	
A3	DLT 7.10(r)	X	X	X	
A4	Logical Error				X

Comments:

1) A table or routine may have to be developed to determine equivalent area of WWF.

2) DLT 7.10(q) covers Section 7.10.5.1.

Datum 7.10(r)	Source	Label	Number
Arrangement of longitudinal bars.	X		
If circular ties used.	X		
If circular ties are complete.	X		

DLT 7.10(r) Circular Tie Requirement Check		1	2	3	4
C1	Longitudinal bars located around the perimeter of a circle?	Y	Y	N	N
C2	Complete circular ties used?	Y	N	Y	N
A1	Provisions = satisfied	X			
A2	Provisions ≠ satisfied		X	X	
A3	DLT 7.10(s)				X
A4	DLT 7.10(t)	X	X	X	

Comments:

1) The Code in Section 7.10.5.3 uses the word "may" in reference to the use of circular ties for longitudinal bars arranged in a circular pattern. Strictly, this would indicate that the use of circular ties is optional. However, circular ties for reinforcement in a circular pattern is presented here as a mandatory requirement based upon the explanation in the Commentary.

2) DLT 7.10(r) partially covers Section 7.10.5.3.

Datum 7.10(s)	Source	Label	Number
Tie arrangement and included angles.	X		
Distance from unsupported bar to nearest supported bar measured along tie.	X		

DLT 7.10(s) Tie Arrangement Check		1	2	3
C1	Ties arranged such that every corner and alternate longitudinal bar has lateral support provided by the corner of a tie <u>with</u> an included angle $\leq 135^0$?	Y	Y	N
C2	No longitudinal bar located 6 in. clear on each side along the tie from a laterally supported bar?	Y	N	I
A1	Provisions = satisfied	X		
A2	Provisions ≠ satisfied		X	X
A3	DLT 7.10(t)	X	X	X

Comment: 1) DLT 7.10(s) partially covers Section 7.10.5.3.

Datum 7.10(t)	Source	Label	Number
Vertical spacing of ties.	X		
d_b of longitudinal bars.	X	d_{bl}	
d_b of tie bar <u>or</u> wire.	X	d_{bt}	
Least dimension of compression member.	X	W_{min}	

DLT 7.10(t) Vertical Spacing Check		1	2
C1	Vertical spacing of ties $\leq$ minimum[16 d_{bl}, 48 d_{bt}, W_{min}]?	Y	N
A1	Provisions = satisfied	X	
A2	Provisions ≠ satisfied		X
A3	DLT 7.10(u)	X	X

Comment: 1) DLT 7.10(t) covers Section 7.10.5.2.

Datum 7.10(u)	Source	Label	Number
Vertical location of the first tie above slab or footing.	X		
Tie spacing.	X		

DLT 7.10(u)	Vertical Location Requirement Check	1	2
C1	Ties located vertically $\leq \frac{1}{2}$ ties spacing above top of footing or slab in any story?	Y	N
A1	Provision = satisfied	X	
A2	Provision ≠ satisfied		X
A3	DLT 7.10(v)	X	X

Comment: 1) DLT 7.10(u) partially covers Section 7.10.5.4.

Datum 7.10(v)	Source	Label	Number
Presence of beams or brackets framing into <u>all</u> sides of column.	X		
Location of highest tie with respect to lowest horizontal reinforcement.	X		
Tie spacing.	X		

DLT 7.10(v) Vertical Location Requirement Check		1	2	3	4	5
C1	Beams <u>or</u> brackets frame into all sides of a column?	Y	Y	N	N	E
C2	Ties terminated 3 in. below lowest reinforcement in beam or bracket?	Y	N	I	N	L S
C3	Ties terminated $\leq \frac{1}{2}$ tie spacing below lowest horizontal reinforcement in members supported above?	Y	I	Y	N	E
A1	Provision = satisfied	X		X		
A2	Provision ≠ satisfied		X			
A3	DLT Chapter 7-1	X	X	X	X	
A4	Logical Error					X

Comments:

1) It was assumed that 1/2 minimum tie spacing (C1 of DLT 7.10(t)) is greater than 3 in. when developing the condition entry of this DLT.

2) DLT 7.10(v) partially covers Section 7.10.5.4 and all of Section 7.10.5.5.

Section 7.11 Lateral Reinforcement for Flexural Members

Datum 7.11(a)	Source	Label	Number
Member type and loading conditions.	X		

DLT 7.11(a)	Flexural Member Conditions	1	2
C1	Member = flexural member subjected to stress reversals or torsion at supports?	Y	N
A1	DLT 7.11(b)	X	
A2	DLT 7.11(c)		X

Comment: 1) DLT 7.11(a) is a switching DLT.

Datum 7.11(b)	Source	Label	Number
Lateral reinforcement provided.	X		

	DLT 7.11(b) Lateral Reinforcement Requirement Check	1	2	3	4
C1	Lateral reinforcement provided = closed ties or closed stirrups extending around the reinforcement?	Y	N	N	E L S E
C2	Lateral reinforcement provided = spirals extending around the flexural reinforcement?	N	Y	N	
A1	Provision = satisfied	X	X		
A2	Provision ≠ satisfied			X	
A3	DLT 7.11(c)	X			
A4	DLT Chapter 7-1		X	X	
A5	Logical Error				X

Comment:

1) DLT 7.11(b) covers Section 7.11.2.

Datum 7.11(c)	Source	Label	Number
Method of forming closed ties or stirrups.	X		

DLT 7.11(c)		1	2	3	4
C1	Closed ties or stirrups formed in one piece by overlapping standard stirrup or tie hook around the longitudinal bar?	Y	N	N	E L
C2	Closed ties or stirrups formed in one or two pieces lap spliced with a Class C splice (lap of 1.7 l_d) or anchored in accordance with Section 7.14?	N	Y	N	S E
A1	Provisions = satisfied	X	X		
A2	Provisions ≠ satisfied			X	
A3	DLT Ch. 7-1	X	X	X	
A4	Logical Error				X

Comments:

1) It was assumed that one or the other of the methods (C1 or C2) would be used, but not both.

2) It was assumed that C1 and C2 are the only Code-approved methods.

3) DLT 7.11(c) covers Section 7.11.3.

Section 7.12 Shrinkage and Temperature Reinforcement

Datum 7.12(a)	Source	Label	Number
If member = roof <u>or</u> floor slab.	X		
If one or two directions of flexural reinforcement.	X		
Presence of shrinkage and temperature reinforcement normal to flexural reinforcement.	X		

DLT 7.12(a) General Requirements Check		1	2	3
C1	Member = roof <u>or</u> floor slab with flexural reinforcement in one direction?	Y	Y	N
C2	Reinforcement for shrinkage and temperature stresses provided normal to flexural reinforcement?	Y	N	I
A1	Provision = satisfied	X		
A2	Provision ≠ satisfied		X	
A3	No provision			X
A4	DLT 7.12(b)	X		
A5	DLT Ch. 7-1		X	X

Comment: 1) DLT 7.12(a) covers Section 7.12.1.

Datum 7.12(b)	Source	Label	Number
Actual spacing of reinforcement slab	X		
Slab thickness.	X	t	
Yield strength of reinforcement.	X	f_y	
Compliance of splices and development length for tension per Section 12.1 or 12.6.	X (from Ch. 12)		

DLT 7.12(b)	Spacing and Development Requirements Check	1	2	3
C1	Spacing $\leq$ minimum[5 t , 18 in.]?	Y	Y	N
C2	Yield strength developed in reinforcement by splices <u>or</u> end development in accordance with applicable parts of Section 12.1 and Section 12.16?	Y	N	I
A1	Provisions = satisfied	X		
A2	Provisions ≠ satisfied		X	X
A3	DLT 7.12(c)	X	X	X

Comment: 1) DLT 7.12(b) covers Section 7.12.4.

Datum 7.12(c)	Source	Label	Number
Specified yield strength of reinforcement.	X	f_y	

DLT 7.12(c)	Minimum Reinforcement Ratio Requirement	1	2	3	4	5
C1	Reinforcement = deformed GR 40 <u>or</u> 50 bars?	Y	N	N	N	ELSE
C2	Reinforcement = GR 60 deformed bar <u>or</u> smooth <u>or</u> deformed welded wire fabric?	N	Y	N	N	
C3	Reinforcement with yield strength > 60,000 psi measured at yield strain of 0.35%?	N	N	Y	N	
A1	Minimum AS/AG = 0.0020	X				
A2	Minimum AS/AG = 0.0018		X			
A3	Minimum AS/AG = maximum $\left[.0014, \frac{.0018 \times 60,000}{f_y}\right]$			X		
A4	No provision, DLT Chapter 7-1				X	
A5	DLT 7.12(d)	X	X	X		
A6	Logical Error					X

Comments:

1) No provision contained for GR40 or 50 smooth bars.

2) DLT 7.12(c) partially covers Section 7.12.2.

Datum 7.12(d)	Source	Label	Number
Actual ratio of reinforcement area to gross concrete area.	X	AS/AG	
Minimum ratio of reinforcement area to gross concrete area.	DLT 7.12 (c)	MIN AS/AG	

DLT 7.12(d) Reinforcement Ratio Requirement Check		1	2
C1	Actual AS/AG $\geq$ MIN AS/AG?	Y	N
A1	Provisions = satisfied	X	
A2	Provisions $\neq$ satisfied		X
A3	DLT Ch. 7-1	X	X

Comment: 1) DLT 7.12(d) covers Section 7.12.2.

NOTATION

A_c	Area of core of spirally reinforced compression member measured to the outside diameter of the spiral, sq. in.
A_g	Gross area of section, sq in.
AS/AG	Actual ratio of reinforcement area to gross concrete area
CDBBL	Clear distance between bars in a layer
CDEM	Clear distance between pretensioning tendons at the end of a member, in.
d_b	Nominal diameter of bar, wire, or prestressing strand; diameter derived from the equivalent total area of bundled bars, in.
d_{bl}	Diameter of longitudinal bars, in.
d_{bt}	Diameter of tie bar or wire, in.
d_{sp}	Diameter of spiral
f'_c	Specified concrete strength, psi
$\sqrt{f'_c}$	Square root of compressive strength of concrete, psi
f_{ct}	Extreme fiber stress in tension in precompressed tensile zone, psi, after allowance for all prestress loss
f_{ysp}	Specified yield strength of spiral reinforcement, psi
l_d	Development length, in. See Chapter 12.
MCC	Minimum concrete cover, in.
MCCD	Minimum concrete cover per design drawings or specifications, in.
MCCFP	Minimum concrete cover for fire protection specified in the general building code, in.
MCDEM	Minimum clear distance between pretensioning tendons at the end of a member, in.
MDB	Minimum diameter of bend measured on the inside of the bar or wire

MINAS/AG	Minimum ratio of reinforcement area to gross concrete area
MNSPR	Minimum number of spacers required
MTS	Minimum tie size, in.
SE	Spiral extension
s_p	Center-to-center spacing of primary flexural reinforcement, in.
s_{pc}	Clear distance between parallel or longitudinal bars, or between a contact lap splice and adjacent splices or bars, in.
t	Thickness of wall or slab, in.
Td	Tolerance on d, in.
TLLBE	Tolerance for longitudinal location of bends & ends, in.
W_{min}	Least dimension of compression member, in.
WWF	Welded wire fabric

ACI CHAPTER 8: ANALYSIS AND DESIGN-GENERAL CONSIDERATIONS

DLT Chapter 8-1		1	2	3	4	5	6	7	8
C1	Design Methods?	Y	N	N	N	N	N	N	
C2	Loading?	N	Y	N	N	N	N	N	E
C3	Methods of Analysis?	N	N	Y	N	N	N	N	L
C4	Redistribution of Negative Moments in Continuous Non-prestressed Flexural Members?	N	N	N	Y	N	N	N	S E
C5	Modulus of Elasticity?	N	N	N	N	Y	N	N	
C6	Stiffness?	N	N	N	N	N	Y	N	
A1	Section 8.1	X							
A2	Section 8.2		X						
A3	Section 8.3			X					
A4	Section 8.4				X				
A5	Section 8.5					X			
A6	Section 8.6						X		
A7	DLT Chapter 8-2							X	
A8	Logical Error								X

DLT Chapter 8-1		1	2	3	4	5	6	7	8
C1	Span Length?	Y	N	N	N	N	N	N	
C2	Columns?	N	Y	N	N	N	N	N	E
C3	Arrangement of Live Load	N	N	Y	N	N	N	N	L
C4	T-Beam Construction	N	N	N	Y	N	N	N	S
C5	Joist Construction	N	N	N	N	Y	N	N	E
C6	Separate Floor Finish	N	N	N	N	N	Y	N	
A1	Section 8.7	X							
A2	Section 8.8		X						
A3	Section 8.9			X					
A4	Section 8.10				X				
A5	Section 8.11					X			
A6	Section 8.12						X		
A7	DLT 318-77 Index							X	
A8	Logical Error								X

Section 8.1 Design Methods

Datum 8.1(a)	Source	Label	Number
Member type.	X		
Method of design.	X		

DLT 8.1(a) Design Method Check		1	2	3	4	5
C1	Member type = nonprestressed concrete?	I	Y	Y	N	E
C2	Member proportioned for adequate strength in accordance with provisions of this Code using load factors and strength reduction factors ϕ specified in Chapter 9?	Y	N	N	N	L S
C3	Member designed using service loads and permissible service load stresses in accordance with provisions of Appendix B - Alternate Design Method?	N	Y	N	I	E
A1	Provision = satisfied	X	X			
A2	Provision ≠ satisfied			X	X	
A3	DLT Chapter 8-1	X	X	X	X	
A4	Logical Error					X

Comment:

1) DLT 8.1(a) covers Sections 8.1.1 and 8.1.2.

Section 8.2 Loading

Datum 8.2(a)	Source	Label	Number
Compliance of service loads and live load reductions with the general building code.	X		
If consideration is given to the effects of forces due to prestressing, crane loads, vibration, impact, shrinkage, temperature changes, creep, and unequal settlement of supports.	X		

DLT 8.2(a)	Loading Requirements Check 1	1	2	3
C1	Service loads and live load reductions used in design in accordance with the general building code?	Y	Y	N
C2	Consideration given to effects of forces due to prestressing, crane loads, vibration, impact, shrinkage, temperature changes, creep, and unequal settlement of supports?	Y	N	I
A1	Provision = satisfied	X		
A2	Provision ≠ satisfied		X	X
A3	DLT 8.2(b)	X	X	X

Comments:

1) DLT 8.2(a) covers Sections 8.2.2 and 8.2.4.

2) Section 8.2.1, as written, states the scope of the Code and is not a provision. It does not appear in the DLTs.

Datum 8.2(b)	Source	Label	Number
If the integral parts are designed to resist the total lateral loads due to wind and earthquake loads.	X		

DLT 8.2(b) Loading Requirements Check 2		1	2
C1	Integral structural parts designed to resist total lateral loads due to wind and earthquake conditions?	Y	N
A1	Provision = satisfied	X	
A2	Provision ≠ satisfied		X
A3	DLT Ch. 8-1	X	X

Comments:

1) DLT 8.2(b) covers Section 8.2.3.

2) The phrase "integral structural parts" is assumed to mean the fixed configuration of structural elements which comprise the structure. It is assumed that it is this assemblage which must resist the total lateral load. One could interpret the language of Section 8.2.3 to mean that each integral part must be designed to resist the total lateral load.

Section 8.3 Methods of Analysis

Datum 8.3(a)	Source	Label	Number
Building construction, spans, and story heights.	X		
Prestressed or nonprestressed construction.	X		
Design method for members of frames or continuous construction.	X		
If simplifying assumptions of Sections 8.6 - 8.9 were used.	X		

DLT 8.3(a)	Method of Analysis Check	1	2	3	4
C1	Building of usual type of construction, spans, and story heights?	I	I	Y	N
C2	Prestressed concrete structure?	I	Y	N	N
C3	Member of frame or continuous construction designed for maximum effects of factored loads as determined by the theory of elastic analysis?	Y	N	N	N
C4	Simplifying assumptions of Sections 8.6-8.9 used?	I	I	I	I
A1	Provision = satisfied	X		X	
A2	Provision ≠ satisfied		X		X
A3	DLT Chapter 8-1	X	X		X
A4	DLT 8.3(b)			X	

Comments:

1) DLT 8.3(a) represents Sections 8.3.1 and 8.3.2.

2) The meaning is not precise, in Section 8.3.1, of the phrase "except as modified according to Section 8.3." It could refer to the last sentence of 8.3.1 or to Section 8.3.3. However, 8.3.3 is described as an approximate method.

3) If the response to C3 is (N), it is implicit in this DLT that approximate methods of analysis were used.

4) "Usual type of construction, etc." in Section 8.3.2 is not defined.

Datum 8.3(b)	Source	Label	Number
Member type.	X		

DLT 8.3(b) Member Type		1	2
C1	Member = beam <u>or</u> one-way slab?	Y	N
A1	DLT 8.3(c)	X	
A2	Approximate methods of Section 8.3 do not apply: DLT Ch. 8-1		X

Comment: 1) DLT 8.3(b) covers Section 8.3.3 - narrative portion.

Datum 8.3(c)	Source	Label	Number
Number of spans	X		
Lengths of adjacent spans	X	ℓ_a, ℓ_b	
If load = uniform	X		
Magnitude of live load and dead load.	X		

DLT 8.3(c)		1	2	3	4	5	6
C1	More than one span?	Y	Y	Y	Y	N	E
C2	$\ell_a \leq 1.2\ \ell_b$	Y	Y	Y	N		L
C3	Loads uniformly distributed?	Y	Y	N	I	I	S
C4	Unit live load $\leq$ 3 times unit dead load?	Y	N	I	I	I	E
A1	DLT 8.3(d)	X					
A2	Approximate methods of Section 8.3.3 do not apply.		X	X	X	X	
A3	DLT Chapter 8-1		X	X	X	X	
A4	Logical Error						X

Comments:

1) DLT 8.3(c) covers Section 8.3.3 - narrative portion.

2) ℓ_a and ℓ_b are adjacent spans where $\ell_a > \ell_b$.

Datum 8.3(d)	Source	Label	Number
Location of span.	X		
Condition of discontinuous end.	X		

DLT 8.3(d)	Positive Moment Values	1	2	3	4
C1	Span = end span?	Y	Y	N	ELSE
C2	Discontinuous end integral with support?	Y	N		
A1	PDM = $\frac{1}{11} W_u \ell_n^2$		X		
A2	PDM = $\frac{1}{14} W_u \ell_n^2$	X			
A3	PDM = $\frac{1}{16} W_u \ell_n^2$			X	
A4	DLT 8.3(e)	X	X	X	
A5	Logical Error				X

Comment: 1) DLT 8.3(d) partially covers the tables of Section 8.3.3.

Datum 8.3(e)	Source	Label	Number
Positive moment used in design.	X		
Positive design moment required	DLT 8.3 (d)	PDM	

DLT 8.3(e) Positive Moment Check		1	2
C1	Positive moment used in design $\geq$ PDM?	Y	N
A1	Provision = satisfied	X	
A2	Provision $\neq$ satisfied		X
A3	DLT 8.3(f)	X	X

Comment: 1) DLT 8.3(e) partially covers the tables of Section 8.3.3.

Datum 8.3(f)	Source	Label	Number
Location of cross section.	X		

DLT 8.3(f) Design Shear Values		1	2
C1	Section - face of 1st interior support in end members?	Y	N
A1	$V = \frac{1}{2}[1.15\ W_u \ell_n]$	X	
A2	$V = \frac{1}{2}\ W_u \ell_n$		X
A3	DLT 8.3(g)	X	X

Comment: 1) DLT 8.3(f) partially covers the tables of Section 8.3.3.

Datum 8.3(g)	Source	Label	Number
Shear value used.	X		
Design shear.	DLT 8.3(f)	V	

DLT 8.3(g) Shear Check		1	2
C1	Shear value used $\geq$ V?	Y	N
A1	Provision = satisfied	X	
A2	Provision $\neq$ satisfied		X
A3	DLT 8.3(h)	X	X

Comment: 1) DLT 8.3(g) partially covers the tables of Section 8.3.

Datum 8.3(h)	Source	Label	Number
ℓ_n of slab	X		
Member Type	X		
$\Sigma K_c/\Sigma K_b$	X		

DLT 8.3(h) Design Negative Moment - 1		1	2	3	4	5
C1	Member = slab?	Y	Y	N	N	E L S E
C2	$\ell_n \leq 10$ ft?	Y	N			
C3	Member = beam where $\Sigma K_c/\Sigma K_b > 8$ at each end of span?			Y	N	
A1	NDM= $\frac{1}{12} W_u \ell_n^2$	X		X		
A2	DLT 8.3(ℓ)	X		X		
A3	DLT 8.3(i)		X		X	
A4	Logical Error					X

Comments:

1) DLT 8.3(h) covers portions of Section 8.3.3 on negative moment.

2) As written, it appears that the NDM (negative design moment) given in A1 applies to the section at the face supports including a supported edge of a slab because it is stated in the Code that the NDM provided applies to all supports.

Datum 8.3(i)	Source	Label	Number
Location of cross section	X		

DLT 8.3(i) Negative Design Moment - 2		1	2	3	4	5
C1	Section = exterior face of 1st interior support?	Y	N	N	N	ELSE
C2	Section = other face of interior support?	N	Y	N	N	
C3	Section = interior face of exterior support?	N	N	Y	N	
A1	DLT 8.3(j)	X				
A2	NDM = $\frac{1}{11} w_u \ell_n^2$		X			
A3	DLT 8.3(k)			X		
A4	No provision: DLT Ch. 8-1				X	
A5	Logical Error					X

Comment: 1) DLT 8.3(i) partially covers the tables of Section 8.3.3.

Datum 8.3(j)	Source	Label	Number
Number of spans.	X		

DLT 8.3(j)	Negative Design Moment - 3	1	2	3
C1	Number of spans = 2?	Y	N	E L S E
C2	Number of spans > 2?	N	Y	
A1	NDM = $\frac{1}{9} W_u \ell_n^2$	X		
A2	NDM = $\frac{1}{10} W_u \ell_n^2$		X	
A3	DLT 8.3(ℓ)	X	X	
A4	Logical Error			X

Comment:

1) DLT 8.3(j) partially covers the tables of Section 8.3.3.

Datum 8.3(k)	Source	Label	Number
If member integral with support.	X		
Type of support.	X		

DLT 8.3(k) Negative Design Moment - 4		1	2	3	4	5
C1	Member built integrally with support?	Y	Y	N	N	ELSE
C2	Support = spandrel beam?	Y	N	Y	N	
C3	Support = column?	N	Y	N	Y	
A1	NDM = $\frac{1}{24} W_u \ell_n^2$	X				
A2	NDM = $\frac{1}{16} W_u \,_n^2$		X			
A3	DLT 8.3(ℓ)	X	X			
A4	No provisions: DLT Chapter 8-1			X	X	
A5	Logical Error					X

Comment:

1) DLT 8.3(k) partially covers the tables of Section 8.3.3.

Datum 8.3 (ℓ)	Source	Label	Number
Negative Moment used in design.	X		
Required negative design moment.	DLT 8.3 (h,i,j,k)	NDM	

DLT 8.3 (ℓ)	Negative Design Moment Check	1	2
C1	Negative design moment used $\geq$ NDM?	Y	N
A1	Provision = satisfied	X	
A2	Provision $\neq$ satisfied		X
A3	DLT Chapter 8-1	X	X

Comment:

1) DLT 8.3(ℓ) partially covers the tables of Section 8.3.3.

Section 8.4 Redistribution of Negative Moments in Continuous Nonprestressed Flexural Members

Datum 8.4(a)	Source	Label	Number
Use of approximate values or elastic theory to determine negative moments.	X		

DLT 8.4(a) Redistribution - 1		1	2	3	4
C1	Approximate values for design moments used?	Y	N	N	ELSE
C2	Negative moments at supports calculated by elastic theory?	N	Y	N	
A1	Redistribution not permitted: DLT Chapter 8-1	X			
A2	DLT 8.4(b)		X		
A3	No provision: DLT Chapter 8-1			X	
A4	Logical Error				X

Comments:

1) DLT 8.4(a) partially covers Section 8.4.1.

2) For criteria on moment redistribution for prestressed concrete members, see Section 18.10.4.

Datum 8.4(b)	Source	Label	Number
Negative moment increased <u>or</u> decreased.	X		
Ratio of nonprestressed tension reinforcement.	X	ρ	
Ratio of nonprestressed compression reinforcement.		ρ'	
Reinforcement ratio producing balanced strain conditions.		ρ_b	

DLT 8.4(b)	Applicability of Redistribution	1	2	3	4	5
C1	Negative moment at support increased?	Y	N	N	N	ELSE
C2	Negative moment at support decreased?	N	Y	N	Y	
C3*	ρ <u>or</u> $(\rho - \rho')$ at support $\leq 0.5\ \rho_b$?	I	Y	I	N	
A1	DLT 8.4(c)	X	X			
A2	Redistribution not permitted				X	
A3	DLT Chapter 8-1			X	X	
A4	Logical Error					X

Comments:

1) DLT 8.4(b) covers Section 8.4.3.

2) Section 8.4.3 is interpreted to mean that if negative moment is increased, the constraints on ρ or $(\rho - \rho')$ do not apply.

3) The phraseology of Section 8.4.3 is such that one could infer that redistribution is permitted only if moments are <u>reduced</u> and ρ or $(\rho - \rho')$ satisfy stated requirements.

---

* $\rho b = \dfrac{0.85\ \beta_1 f'_c\ 87000}{f_y\ 87000} + f_y$.

Datum 8.4(c)	Source	Label	Number
Amount of decrease or increase in negative moment.	X		
Ratio of nonprestressed tension reinforcement.	X	ρ	
Ratio of nonprestressed compression reinforcement.	X	ρ'	
Reinforcement ratio producing balanced strain conditions.		ρ_b	

DLT 8.4(c)	Amount of Change Check	1	2
C1	Amount of increase <u>or</u> decrease in negative moment $\leq 20\left(1 - \frac{\rho - \rho'}{\rho_b}\right)\%$?	Y	N
A1	Provision = satisfied	X	
A2	Provision ≠ satisfied		X
A3	DLT 8.4(d)	X	X

Comment:

1) DLT 8.4(c) partially covers Section 8.4.1.

Datum 8.4(d)	Source	Label	Number
If modified negative moment is used to calculate moment at sections within the spans.	X		

DLT 8.4(d) Moment Check		1	2
C1	Moments at sections within spans calculated using modified negative moments?	X	X
A1	Provision = satisfied	X	
A2	Provision ≠ satisfied		X
A3	DLT Chapter 8-1	X	X

Comment:

1) DLT 8.4(d) covers Section 8.4.2.

Section 8.5 Modulus of Elasticity

Datum 8.5(a)	Source	Label	Number
Unit weight of concrete, lb per cu ft.	X	W_c	
If normal weight concrete used.	X		
Specified compressive strength of concrete, psi.	X	f'_c	

	DLT 8.5(a) Modulus of Elasticity Value	1	2	3	4
C1	$90\ lb/ft^3 \leq W_c \leq 155\ lb/ft^3$?	Y	Y	N	ELSE
C2	Normal weight concrete?	Y	N	N	
A1	$E_c = W_c^{1.5}\ 33\sqrt{f'_c}$		X		
A2	$E_c = 57000\ \sqrt{f'_c}$	X			
A3	No value provided			X	
A4	DLT 8.5(b)	X	X	X	
A5	Logical Error				X

Comment:

1) DLT 8.5(a) partially covers Section 8.5.1.

Datum 8.5(b)	Source	Label	Number
Modulus of elasticity of concrete used in design.	X		
Modulus of elasticity of concrete provided by Code.	X	E_c	

DLT 8.5(b)	Modulus of Elasticity of Concrete Check	1
C1	Modulus of elasticity of concrete used in design = E_c?	I
A1	Provision = satisfied	X
A2	DLT 8.5(c)	X

Comments:

1) DLT 8.5(b) partially covers Section 8.5.1.

2) The use of the word "may" in Section 8.5.1 indicates that the values provided for E_c are not requirements.

Datum 8.5(c)	Source	Label	Number
Modulus of elasticity of nonprestressed reinforcement.	X	E_s	
If modulus of elasticity for prestressing tendons was supplied by manufacturer <u>or</u> determined by test.	X		

DLT 8.5(c)	Modulus of Elasticity Check	1	2	3	4
C1	Nonprestressed reinforcement?	Y	N	N	E
C2	E_s = 29,000,000 psi?	I			L S
C3	E_s determined by test or supplied by manufacturer?		Y	N	E
A1	Provision = satisfied.	X	X		
A2	Provision ≠ satisfied.			X	
A3	DLT Ch. 8-1.	X	X	X	
A4	Logical Error				X

Comments:

1) DLT 8.5(c) covers Sections 8.5.2 and 8.5.3.

2) The response to C2 is (I) because E_s = 29,000,000 is not mandatory.

Section 8.6 Stiffness

Datum 8.6(a)	Source	Label	Number
Assumptions adopted for computing relative flexural and torsional stiffness of columns, walls, floors and roof systems.	X		
If assumptions are consistent throughout analysis.	X		

DLT 8.6(a) Assumptions Check		1	2	3
C1	Assumptions adopted for computing relative flexural and torsional stiffness of columns, walls, floors and roof systems = reasonable?	Y	Y	N
C2	Assumptions consistent throughout analysis?	Y	N	I
A1	Provisions = satisfied	X		
A2	Provisions ≠ satisfied		X	X
A3	DLT 8.6(b)	X	X	X

Comment:

1) DLT 8.6(a) covers Section 8.6.1.

Datum 8.6(b)	Source	Label	Number
If the effect of haunches was considered in determining moments <u>and</u> in design of members.	X		

DLT 8.6(b)	Effect of Haunches Check	1	2
C1	Effect of haunches considered in determining moments <u>and</u> in design of members?	Y	N
A1	Provisions = satisfied	X	
A2	Provisions ≠ satisfied		X
A3	DLT Ch. 8-1	X	X

Comment:

1) DLT 8.6(b) covers Section 8.6.2.

Section 8.7 Span Length

Datum 8.7(a)	Source	Label	Number
If the member is integral with the support.	X		
If the member is an element of a frame or continuous construction.	X		

DLT 8.7(a) Span Length Requirement		1	2	3
C1	Member built integrally with supports?	I	Y	N
C2	Member = element of frame <u>or</u> continuous construction?	Y	N	N
A1	Span length = min. [clear span + depth of member, distance between centers of supports]			X
A2	Span length = distance center-to-center of supports	X		
A3	DLT 8.7(b)		X	
A4	DLT 8.7(c)	X		X

Comments:

1) DLT 8.7(a) partially covers Sections 8.7.1 and 8.7.2.

2) It was assumed in forming Decision Rule #1 that the requirements of Section 8.7.2 take precedence over those of Section 8.7.1 in the case where the member is both built integrally with supports and an element of a frame or continuous construction.

Datum 8.7(b)	Source	Label	Number
Member type.	X		
If moments at face of support used for design.	X		
If slab or ribbed slab analyzed as a continuous slab on knife edge support with spans equal to the clear spans of the slab and width of beams otherwise neglected.	X		
Clear span of slab.	X		

DLT 8.7(b)	Beam and Slab Check	1	2	3	4
C1	Member type = beam?	Y	N	N	E
C2	Moments at face of support used for design?	I			L
C3	Member type = solid <u>or</u> ribbed slab with clear span $\leq$ 10 ft?	N	Y	N	S
C4	Analyzed as a continuous slab on knife edge support with spans equal to the clear spans of the slab and width of beams otherwise neglected?		I		E
A1	Provision = satisfied	X	X		
A2	No provision			X	
A3	DLT Ch. 8-1	X	X	X	
A4	Logical Error				X

Comments:

1) DLT 8.7(b) covers Sections 8.7.3 and 8.7.4.

2) All provisions are optional, hence responses to C2 and C4 are immaterial (I) to the outcome A1.

Datum 8.7(c)	Source	Label	Number
Span length used in design.	X		
Span length required.	DLT 8.7(a)		

DLT 8.7(c) Span Length Check		1	2
C1	Span length used in design = span length required?	Y	N
A1	Provision = satisfied	X	
A2	Provision ≠ satisfied		X
A3	DLT Ch. 8-1	X	X

Comment:

1) DLT 8.7(c) partially covers Sections 8.7.1, 8.7.2 and 8.7.4.

Section 8.8 Columns

Datum 8.8(a)	Source	Label	Number
If columns designed to resist the axial forces from factored loads on all floors or roof.	X		
If columns were designed to resist the maximum moment from factored loads on a single adjacent span of the floor or roof under consideration.	X		
If loading condition giving the maximum ratio of moment to axial load was considered.	X		

DLT 8.8(a)	Column Check - 1	1	2	3	4
C1	Columns designed to resist the axial forces from factored loads on all floors or roof?	Y	Y	Y	N
C2	Columns designed to resist the maximum moment from factored loads on a single adjacent span of the floor or roof under consideration?	Y	Y	N	I
C3	Loading condition giving the maximum ratio of moment to axial load considered?	Y	N	I	I
A1	Provision = satisfied	X			
A2	Provision ≠ satisfied		X	X	X
A3	DLT 8.8(b)	X	X	X	X

Comment:

1) DLT 8.8(a) covers Section 8.8.1.

Datum 8.8(b)	Source	Label	Number
If column is in a frame or used in continuous construction.	X		
If consideration given to the effect of unbalanced floor or roof loads on both exterior and interior columns.	X		
If consideration given to the effect of eccentric loading due to other courses.	X		

DLT 8.8(b)		1	2	3	4	5
C1	Column in a frame or used in continuous construction?	Y	Y	Y	N	E
C2	Consideration given to the effect of unbalanced floor or roof loads on both exterior and interior columns?	Y	Y	N		L S
C3	Consideration given to the effect of eccentric loading due to other causes?	Y	N	I		E
A1	Provision = satisfied	X				
A2	Provision ≠ satisfied		X	X		
A3	DLT 8.8(c)	X	X	X	X	
A4	Logical Error					X

Comment:

1) DLT 8.8(b) covers Section 8.8.2.

Datum 8.8(c)	Source	Label	Number
If resistance to moments at any floor or roof level is provided by distributing the moment between columns immediately above and below the given floor in proportion to the relative column stiffness and conditions of restraint.	X		
If the far ends of columns built integrally with the structure are considered fixed when computing moments in columns.	X		

DLT 8.8(c)	Moment Distribution Requirement	1	2
C1	Resistance to moments at any floor or roof level provided by distributing the moment between columns immediately above and below the given floor in proportion to the relative column stiffness and conditions of restraint?	Y	N
C2	Far ends of columns built integrally with the structure considered fixed when computing moments in columns?	I	I
A1	Provisions = satisfied	X	
A2	Provisions ≠ satisfied		X
A3	DLT Ch. 8-1	X	X

Comment:

1) DLT 8.8(c) covers Sections 8.8.3 and 8.8.4.

Section 8.9 Arrangement of Live Load

Datum 8.9(a)	Source	Label	Number
If live load considered to be applied only to the floor or roof under consideration.	X		
If far ends of columns built integrally with the structure are considered fixed.	X		

DLT 8.9(a)	Live Load Arrangement Check - 1	1
C1	Live load considered to be applied only to the floor <u>or</u> roof under consideration?	I
C2	Far ends of columns built integrally with the structure considered fixed?	I
A1	Provision = satisfied	X
A2	DLT 8.9(b)	X

Comment:

1) DLT 8.9(a) covers Section 8.9.1.

Datum 8.9(b)	Source	Label	Number
If factored dead load on all spans with full factored live load on two adjacent spans.	X		
If factored dead load on all spans with full factored live load on alternate spans.	X		

DLT 8.9(b)	Live Load Arrangement Check - 2	1	2	3
C1	Factored dead load on all spans with full factored live load on two adjacent spans?	Y	Y	N
C2	Factored dead load on all spans with full factored live load on alternate spans?	Y	N	I
A1	Provisions = satisfied	X		
A2	Provisions ≠ satisfied		X	X
A3	DLT Ch. 8-1	X	X	X

Comments:

1) DLT 8.9(b) covers Section 8.9.2.
2) Section 8.9.2 is interpreted to be minimum requirements.

Section 8.10 T-Beam Construction

Datum 8.10(a)	Source	Label	Number
Flange and web built integrally *or* otherwise effectively bonded together.	X		
Overhanging slab on one side of web.	X		
Isolated beam where T-shape is used to provide a flange for additional compression area.	X		

	DLT 8.10(a) Construction Check	1	2	3	4	5	6	7	8
C1	Flange and web built integrally or otherwise effectively bonded together?	Y	Y	Y	Y	N	N	N	N
C2	Overhanging slab on one side only?	Y	Y	N	N	Y	Y	N	N
C3	Isolated beam where T-shape is used to provide a flange for additional compression area?	Y	N	Y	N	Y	N	Y	N
A1	Provision = satisfied.	X	X	X	X				
A2	Provision ≠ satisfied.					X	X	X	X
A3	DLT 8.10(b).		X				X		
A4	DLT 8.10(c).			X				X	
A5	DLT 8.10(d).				X				X
A6	DLT 8.10(e).	X				X			

Comments:

1) DLT 8.10(a) covers Section 8.10.1 and partially Section 8.10.4.

2) Decision Rules 1 and 5 represent the case of an isolated beam with a flange on one side only. This probably is not a likely physical possibility, but the Code seems to classify this type as a 7-beam. Therefore, Rules 1 and 5 become a logical possibility.

Datum 8.10(b)	Source	Label	Number
Beam span length.	X	ℓ	
Slab thickness.	X	t	
Clear distance between adjacent webs.	X	ℓ_t	

DLT 8.10(b) Flange Requirements Check - 1		1	2
C1	Overhanging flange width $\leq$ min $[\frac{1}{12}\ell, 6t, \frac{1}{2}\ell_t]$	Y	N
A1	Provisions = satisfied	X	
A2	Provisions ≠ satisfied		X
A3	DLT 8.10(e)	X	X

Comment:

1) DLT 8.10(b) covers Section 8.10.3.

Datum 8.10(c)	Source	Label	Number
Flange thickness.	X		
Width of web.	X	b_w	
Effective flange width.	X		

DLT 8.10(c)	Flange Requirements Check - 2	1	2	3
C1	Flange thickness $\geq \frac{1}{2}\ b_w$?	Y	Y	N
C2	Effective flange width $\leq 4\ b_w$?	Y	N	I
A1	Provision = satisfied	X		
A2	Provision $\neq$ satisfied		X	X
A3	DLT 8.10(e)	X	X	X

Comment:

1) DLT 8.10(c) covers Section 8.10.4.

Datum 8.10(d)	Source	Label	Number
Span length of beam.	X	ℓ	
Width of slab effective as a flange.	X		
Slab thickness.	X	t	
Effective overhanging slab width on each side of the web.	X		
Clear distance to the next web.	X	ℓ_t	

DLT 8.10(d) Flange Requirements - 3		1	2	3
C1	Width of slab effective as flange $\leq \frac{1}{4}\ \ell$?	Y	Y	N
C2	Effective overhanging slab width on each side of web $\leq$ min $[8t,\ \frac{1}{2}\ell_t]$?	Y	N	I
A1	Provisions = satisfied	X		
A2	Provisions $\neq$ satisfied		X	X
A3	DLT 8.10(e)	X	X	X

Comment:

1) DLT 8.10(d) covers Section 8.10.2.

Datum 8.10(e)	Source	Label	Number
If primary flexural reinforcement in a slab that is considered as T-beam flange (excluding joist construction) is parallel to the beam.	X		

DLT 8.10(e)	Orientation of Primary Reinforcement	1	2
C1	Is the primary reinforcement in a slab that is considered as a T-beam flange (excluding joist construction) parallel to the beam?	Y	N
A1	DLT 8.10(f)	X	
A2	DLT Ch. 8-1		X

Comment:

1) DLT 8.10(e) covers Section 8.10.5.

Datum 8.10(f)	Source	Label	Number
Transverse reinforcement designed to carry factored load on the overhanging slab width acting as a cantilever.	X		
Spacing of transverse reinforcement.	X		
Slab thickness.	X	t	

DLT 8.10(f)	Transverse Reinforcement Check - 1	1	2	3
C1	Transverse reinforcement designed to carry factored load on the overhanging slab width acting as a cantilever?	Y	Y	N
C2	Spacing of transverse reinforcement $\leq$ min [5t, 18 in.]?	Y	N	I
A1	Provision = satisfied	X		
A2	Provision $\neq$ satisfied		X	
A3	DLT 8.10(g)	X	X	
A4	DLT Ch. 8-1			X

Comment:

1) DLT 8.10(f) partially covers Section 8.10.5.1 and Section 8.10.5.2.

Datum 8.10(g)	Source	Label	Number
If isolated beam.	X		
If full width of overhanging flange considered.	X		
If effective overhanging slab width considered.	X		

DLT 8.10(g) Transverse Reinforcement Check - 2		1	2	3	4	5
C1	Isolated beam?	Y	Y	N	N	ELSE
C2	Full width of overhanging flange considered?	Y	N			
C3	Effective overhanging slab width considered?			Y	N	
A1	Provision = satisfied	X		X		
A2	Provision ≠ satisfied		X		X	
A3	DLT Ch. 8-1	X	X	X	X	
A4	Logical Error					X

Comment:

1) DLT 8.10(g) partially covers Section 8.10.5.1.

Section 8.11 Joist Construction

Datum 8.11(a)	Source	Label	Number
Monolithic combination of top slab and regularly spaced ribs which span in one direction <u>or</u> two orthogonal directions.	X		
Minimum width of rib.	X	b_w	
Clear span (spacing)	X	ℓ_t	
Depth (height) of rib	X	h_r	

DLT 8.11(a) Configuration Check		1	2	3	4
C1	Monolithic combination of top slab and regularly spaced ribs which span in one direction <u>or</u> two orthogonal directions?	Y	Y	Y	N
C2	$b_w \geq 4$ in. <u>and</u> $h_r \leq 3\frac{1}{2}\, b_w$?	Y	Y	N	I
C3	$\ell_t \leq 30$ in.?	Y	N	I	I
A1	Provisions = satisfied	X			
A2	Provisions ≠ satisfied		X	X	X
A3	DLT 8.11(b)		X	X	X
A4	DLT 8.11(c)	X			

Comment:

1) DLT 8.11(a) covers Sections 8.11.1, 8.11.2, and 8.11.3.

Datum 8.11(b)	Source	Label	Number
If construction designed as slabs and beams.	X		

DLT 8.11(b) Slab and Beam Check		1	2
C1	Construction designed as slabs and beams?	Y	N
A1	Provision = satisfied	X	
A2	Provision ≠ satisfied		X
A3	DLT Ch. 8-1	X	X

Comment:

1) DLT 8.11(b) covers Section 8.11.4.

Datum 8.11(c)	Source	Label	Number
Value of shear strength provided by concrete used in design.	X	$\overline{V}_c$	
Value of shear strength provided by concrete per Ch. 11.	X	V_c	
Shear strength increased by use of shear reinforcement <u>or</u> by widening ends of ribs.	X		

DLT 8.11(c) Shear Strength Check		1	2
C1	$\overline{V}_c = 1.10\ V_c$?	Y	N
C2	Shear strength increased by use of shear reinforcement <u>or</u> by widening the ends of the ribs?	I	I
A1	Provision = satisfied	X	X
A2	DLT 8.11(d)	X	X

Comments:

1) DLT 8.11(c) covers Section 8.11.8.

2) All provisions of Section 8.11.8 are optional.

3) The Code, as written, permits $\overline{V}_c$ to exceed V_c by <u>exactly</u> 10%. The intent is probably for $\overline{V}_c$ to exceed V_c by <u>at most</u> 10%.

Datum 8.11(d)	Source	Label	Number
Use of permanent burned clay or concrete fillers.	X		
Use of removable forms or fillers.	X		
Unit compressive strength of permanent filler.	X	f_f	
Specified strength of concrete in joists.	X	f'_c	

	DLT 8.11(d) Filler Requirements Check	1	2	3	4	5
C1	Permanent burned clay or concrete tile fillers used?	Y	Y	N	N	E L S E
C2	$f_f \geq f'_c$ for joist concrete?	Y	N			
C3	Removable fillers or forms used?			Y	N	
A1	Provision = satisfied	X				
A2	Provision ≠ satisfied		X			
A3	DLT 8.11(e)	X				
A4	DLT 8.11(h)			X		
A5	DLT 8.11(i)		X		X	
A6	Logical Error					X

Comment:

1) DLT 8.11(d) partially covers Section 8.11.5.

Datum 8.11(e)	Source	Label	Number
If portions of fillers other than vertical shells in contact with ribs included in strength computations.	X		
If vertical shells of fillers in contact with ribs included in strength computations for shear and moment.	X		

DLT 8.11(e) Use of Fillers for Strength Check		1	2
C1	Portions of fillers other than vertical shells in contact with ribs included in strength computations?	Y	N
C2	Vertical shells of fillers in contact with ribs included in strength computations for shear and negative moment?	I	I
A1	Provisions = satisfied		X
A2	Provisions ≠ satisfied	X	
A3	DLT 8.11(f)	X	X

Comment:

1) DLT 8.11(e) covers Section 8.11.5(a).

Datum 8.11(f)	Source	Label	Number
Slab thickness (over fillers)	X	t	
Clear distance between ribs.	X	ℓ_t	

DLT 8.11(f) Slab Thickness Check		1	2
C1	t (over fillers) $\geq$ min $[\frac{1}{12}\ \ell_t,\ 1\frac{1}{2}$ in.]?	Y	N
A1	Provisions = satisfied	X	
A2	Provisions $\neq$ satisfied		X
A3	DLT 8.11(g)	X	X

Comment:

1) DLT 8.11(f) covers Section 8.11.5(b).

Datum 8.11(g)	Source	Label	Number
If one-way joists used.	X		
If reinforcement provided in the slab normal to ribs as required by Section 7.12.	X		

	DLT 8.11(g) Slab Reinforcement Check	1	2	3
C1	One-way joists?	Y	Y	N
C2	Reinforcement provided normal to ribs as required by Section 7.12?	Y	N	I
A1	Provisions = satisfied	X		X
A2	Provisions ≠ satisfied		X	
A3	DLT 8.11(i)	X	X	X

Comment:

1) DLT 8.11(g) covers Section 8.11.5(c).

Datum 8.11(h)	Source	Label	Number
Slab thickness.	X	t	
Clear distance between ribs.	X	ℓ_t	
If reinforcement provided in the slab normal to the ribs as required for flexure considering concentrations <u>and</u> $\geq$ amount required by Section 7.12.	X		

DLT 8.11(h)	Slab and Reinforcement Requirements Check	1	2	3
C1	$t \geq \min\ [\frac{1}{2}\ \ell_t,\ 2\text{ in.}]$?	Y	Y	N
C2	Reinforcement provided normal to ribs as required for flexure considering concentrations <u>and</u> $\geq$ that required by Section 7.12?	Y	N	I
A1	Provision = satisfied	X		
A2	Provision $\neq$ satisfied		X	X
A3	DLT 8.11(i)	X	X	X

Comment:

1) DLT 8.11(h) covers Section 8.11.6.

Datum 8.11(i)	Source	Label	Number
Presence of conduits or pipes as permitted by Section 6.3 embedded within the slab.	X		
Slab thickness.		t	
Overall depth of conduits or pipes.	X		
Effect of conduits or pipes on the strength of the construction.	X		

DLT 8.11(i)	Conduits or Pipes Effect Check	1	2	3	4
C1	Conduits or pipes embedded in the slab as permitted by Section 6.3?	Y	Y	Y	N
C2	Strength of construction significantly impaired by conduits or pipes?	Y	N	N	
C3	t $\geq$ overall depth of the conduits or pipes plus 1 in.?	I	Y	N	
A1	Provisions = satisfied		X		
A2	Provisions $\neq$ satisfied	X		X	
A3	DLT Ch. 8-1	X	X	X	
A4	Logical Error				X

Comment:

1) DLT 8.11(i) covers Section 8.11.7.

Section 8.12 Separate Floor Finish

Datum 8.12(a)	Source	Label	Number
Floor finish included as part of a structural member.	X		
Floor finish placed monolithically with floor slab.	X		
Floor finish designed in accordance with the requirements of Ch. 17.	X		
Concrete floor finish considered as part of required cover <u>or</u> total thickness for nonstructural considerations.	X		

	DLT 8.12(a) Floor Finish Requirements	1	2	3	4
C1	Is floor finish included as part of a structural member?	Y	Y	N	ELSE
C2	Is floor finish placed monolithically with the floor slab or designed in accordance with the requirements of Ch. 17?	Y	N		
C3	Concrete floor finish considered as part of required cover <u>or</u> total thickness for non-structural considerations?	I	I	I	
A1	Provisions = satisfied	X		X	
A2	Provisions $\neq$ satisfied		X		
A3	DLT Ch. 8-1	X	X	X	
A4	Logical Error				X

Comment:

1) DLT 8.12(a) covers Section 8.12.

NOTATION

A_s Area of nonprestressed tension reinforcement, sq in.

A'_s Area of compression reinforcement, sq in.

b Width of compression force of member, in.

b_w Minimum width of rib, in.

d Distance from extreme compression fiber to centroid of tension reinforcement, in.

E_c Modulus of elasticity of concrete, psi

E_s Modulus of elasticity of reinforcement, psi

f'_c Specified compressive strength of concrete, psi

f_f Unit compressive strength of filler, psi

f_y Specified yield strength of nonprestressed reinforcement, psi

h_r Depth of rib, m

$\ell_{a,b}$ ℓ_a and ℓ_b denote the lengths of adjacent spans where $\ell_a > \ell_b$

K_c Flexural stiffness of column

K_b Flexural stiffness of beam

ℓ_n Clear span for positive moment or shear and average of adjacent clear spans for negative moment

ℓ Span length of a beam

ℓ_t Clear distance between adjacent webs

PDM Positive design moment required

NDM Negative design moment

t Slab or wall thickness, in.

V_c Nominal shear strength provided by concrete

$\overline{V}_c$ Value of shear strength provided by concrete used in design

W_u Factored load per unit length of beam or per unit area of slab

W_c Unit weight of concrete, lb per cu ft

β_1 Factor defined in Section 10.2.7

ρ Ratio of nonprestressed tension reinforcement,

A_s/bd

ρ' Ratio of nonprestressed compression reinforcement,

A'_s/bd

ρ_b Reinforcement ratio producing balanced strain conditions. See Section 10.3

ϕ Strength reduction factor. See Section 9.3

ACI CHAPTER 9: STRENGTH AND SERVICEABILITY REQUIREMENTS

DLT	Chapter 9	1	2	3	4	5	6	7
C1	General Considerations	Y	N	N	N	N	N	E
C2	Required Strength	N	Y	N	N	N	N	L
C3	Design Strength	N	N	Y	N	N	N	S
C4	Design Strength for Reinforcement	N	N	N	Y	N	N	E
C5	Control of Deflections	N	N	N	N	Y	N	
A1	Section 9.1	X						
A2	Section 9.2		X					
A3	Section 9.3			X				
A4	Section 9.4				X			
A5	Section 9.5					X		
A6	DLT 318-77 Index						X	
A7	Logical Error							X

Section 9.1 General

Datum 9.1(a)	Source	Label	Number
Design strength of structures and structural members.	X		
Required strengths calculated for the factored loads and forces in such combinations.	Section 9.2		

DLT 9.1(a) General		1	2	3
C1	Design strength of structures and structural members at all sections $\geq$ required strengths calculated for the factored loads and forces in such combinations as are stipulated in this Code?	Y	Y	N
C2	Members satisfy all other requirements of this Code?	Y	N	I
A1	Provisions = satisfied	X		
A2	Provisions $\neq$ satisfied		X	X
A3	DLT Chapter 9	X	X	X

Comments:

1) DLT 9.1(a) covers Section 9.1.

2) As written in the Code, this Section is a general instructional guide to designers.

3) As a "checking" DLT, it probably belongs at the end of the Code considering the wording of Section 9.1.2 (C2 above).

Section 9.2 Required Strength

Datum 9.2(a)	Source	Label	Number
If resistance to impact effects was considered in design.	X		
Impact effects (loads)	X		
Dead Load	X	D	
Live Load	X	L	

DLT 9.2(a) Impact Effects		1	2
C1	Resistance to impact effects taken into account in design?	Y	N
A1	L = (L + impact)	X	
A2	L = L		X
A3	U_o = (1.4D + 1.7L)	X	X
A4	DLT 9.2(b)	X	X

Comments:

1) DLT 9.2(a) covers Sections 9.2 and 9.2.6.

2) Per the Commentary, "impact effects" are loads to be added to live load if conditions warrant.

Datum 9.2(b)	Source	Label	Number
Loads for which resistance was included in design.	X		
Dead load.	X		
Live load.	X		

DLT 9.2(b) Wind and Earthquake		1	2	3	4
C1	Resistance to structural effects of a specified wind load, W, included in the design?	Y	N	N	E L S E
C2	Resistance to specified earthquake loads on forces, E, included in design?	N	Y	N	
A1	$U_1 = 0.75\ (1.4D + 1.7L + 1.7W)$	X			
A2	$U_2 = 0.75\ (1.4D + 1.7W)$	X			
A3	$U_3 = 0.9D + 1.3W$	X			
A4	$U_4 = 0.75\ (1.4D + 1.7L + 1.87E)$		X		
A5	$U_5 = 0.75\ (1.4D + 1.87E)$		X		
A6	$U_6 = 0.9D + 1.43E$		X		
A7	$U_7 = \mathrm{Max}[U_i: i = 0, 1, \ldots, 6]$	X	X		
A8	DLT 9.2(c)			X	
A9	DLT 9.2(f)	X	X		
A10	Logical Error				X

Comment: 1) DLT 9.2(b) covers Sections 9.2.2 and 9.2.3.

Datum 9.2(c)	Source	Label	Number
Loads for which resistance was included in design.	X		
Basic required strength.	DLT 9.2(a)	U_o	
Lateral earth pressure on related internal moments and forces.	X	H	
Dead loads or related internal moments and forces.	X	D	
Live loads or related internal moments and forces.	X	L	

DLT 9.2(c) Lateral Earth Pressure		1	2	3
C1	Resistance to lateral earth pressure, H, included in design?	Y	Y	N
C2	Does D or L reduce the effect of H?	Y	N	I
A1	$U_7 = (1.4D + 1.7L + 1.7H)$		X	
A2	$U_8 = (0.9D + 1.7H)$	X		
A3	$U = \text{maximum}[U_0, U_7, U_8]$	X	X	
A4	DLT 9.2(f)	X	X	
A5	DLT 9.2(d)			X

Comment: 1) DLT 9.2(c) covers Section 9.2.4.

Datum 9.2(d)	Source	Label	Number
Loads for which resistance was included in design.	X		
If dead load or live load reduces the effect of F?	X		
Basic required strength.	DLT 9.2(a)	U_0	
Dead loads or related internal moments and forces.	X	D	
Live loads or related internal moments and forces.	X	L	
Lateral pressure of liquids or related moments and forces.	X	F	
Vertical liquid pressure.	X		

DLT 9.2(d)	Lateral Liquid Pressure	1	2	3
C1	Resistance to lateral liquid pressure, F, included in design?	Y	Y	N
C2	Does D* or L reduce the effect of F?	Y	N	I
A1	$U_9 = (1.4D + 1.7L + 1.4F)$		X	
A2	$U_{10} = (0.9D + 1.4F)$	X		
A3	$U = \text{maximum}[U_0, U_9, U_{10}]$	X	X	
A4	DLT 9.2(f)	X	X	
A5	DLT 9.2(e)			X

Comment:

1) DLT 9.2(d) covers Section 9.2.5.

* Vertical liquid pressure shall be considered as dead load, D, with due regard to variation in liquid depth.

Datum 9.2(e)	Source	Label	Number
Structural effects of differential settlement, creep, shrinkage, or temperature differential.	X	T	
If T is significant in design.	X		
If estimating differential settlement, creep, shrinkage, or temperature change was based on a realistic assessment of such effects occurring in service.	X		

	DLT 9.2(e) Miscellaneous Effects	1	2	3	
C1	Structural effects, T, of differential settlement, creep, shrinkage, or temperature change significant in design?	Y	Y	N	E L
C2	Were estimations of differential settlement, creep, shrinkage or temperature change based on a realistic assessment of such effects occurring in service?	Y	N		S E
A1	$U_{11} = 0.75\ (1.4D + 1.4T + 1.7L)$	X			
A2	$U_{12} = 1.4\ (D + T)$	X			
A3	$U = \text{maximum}[U_{11}, U_{12}]$	X			
A4	DLT 9.2(f)	X			
A5	DLT Ch 9, No provision		X	X	
A6	Logical Error				X

Comment: 1) DLT 9.2(e) covers Section 9.2.7.

Datum 9.2(f)	Source	Label	Number
Strength provided.	X		
Required strength.	DLT 9.2 (b,c,d,e)	U	

DLT 9.2(f) Strength Check		1	2
C1	Strength provided $\geq$ U?	Y	N
A1	Provision = satisfied	X	
A2	Provision $\neq$ satisfied		X
A3	DLT Ch 9	X	X

Section 9.3 Design Strength

Datum 9.3(a)	Source	Label	Number
Load condition	X		

DLT 9.3(a)	Reduction Factor 1	1	2	3	
C1	Load condition = shear?	Y	N	N	ELSE
C2	Load condition = bearing on concrete?	N	Y	N	
A1	ϕ(shear) = 0.85	X			
A2	DLT 9.3(b)		X		
A3	DLT 9.3(c)			X	
A4	DLT 9.3(g)	X			
A5	Logical Error				X

Comment:

1) DLT 9.3(a) covers Section 9.3.2(d).

Datum 9.3(b)	Source	Label	Number
Location of region of bearing stress.	X		

DLT 9.3(b) Reduction Factor 2		1	2
C1	Stresses at post-tensioning anchorage zone?	Y	N
A1	ϕ(bearing) = 0.70		X
A2	ϕ(anchorage zone) = 0.90	X	
A3	DLT 9.3(g)	X	X

Comment: 1) DLT 9.3(b) covers Sections 9.2.3(e) and 18.13.4.

Datum 9.3(c)	Source	Label	Number
Load condition.	X		
If flexural reinforcement is provided.	X		

DLT 9.3(c) Reduction Factor 3		1	2	3	4	
C1	Load condition = flexure?	Y	Y	N	N	E
C2	Flexural reinforcement provided?	Y	N	I	I	L
C3	Load condition = axial tension?	I	I	Y	N	S
						E
A1	ϕ(flexure) = 0.90	X				
A2	ϕ(flexure) = 0.65		X			
A3	ϕ(axial tension) = 0.90			X		
A4	DLT 9.3(d)				X	
A5	DLT 9.3(g)	X	X	X		
A6	Logical Error					X

Comment: 1) DLT 9.3(c) covers Sections 9.3.2(a), (b), and (f).

Datum 9.3(d)	Source	Label	Number
Load condition. If spiral reinforcement conforming to Section 10.9.3 is used.	X DLT 10.9.3		

DLT 9.3(d) Reduction Factor 4		1	2	3
C1	Load condition - compression?	Y	Y	N
C2	Spiral reinforcement conforming to Section 10.9.3?	Y	N	
A1	ϕ(compression) = 0.75	X		
A2	ϕ(compression) = 0.70		X	
A3	DLT 9.3(e)	X	X	
A4	DLT Ch 9			X

Comment: 1) DLT 9.3(d) covers part of Section 9.3.2(c).

Datum 9.3(e)	Source	Label	Number
If reinforcement pattern is symmetrical.	X		
Specified yield strength of nonprestressed reinforcement.	X	f_y	
Gross area of section, sq in.	X	A_g	
Specified compressive strength of concrete, psi.	X	f'_c	
Overall thickness of member, in.	X	h	
Distance from extreme compression fiber to centroid of compression reinforcement, in.	X	d'	
Distance from extreme tension fiber to centroid of tension reinforcement, in.	X	d_s	
Nominal axial load strength at given eccentricity.	X	P_n	
Strength reduction factor.	DLT 9.3(d)	ϕ	

DLT 9.3(e)	Special Conditions	1	2	3	4	5
C1	Reinforcement pattern = symmetrical?	N	Y	Y	Y	Y
C2	$f_y > 60{,}000$?	I	Y	N	N	N
C3	$\phi P_n > 0.10\ A_g f'_c$?	I	I	Y	N	N
C4	$(h - d' - d_s)/h > 0.70$?	I	I	I	N	Y
A1	Special conditions satisfied.					X
A2	DLT 9.3(f)	X	X	X	X	X

Comment: 1) DLT 9.3(e) covers part of Section 9.3.2(c).

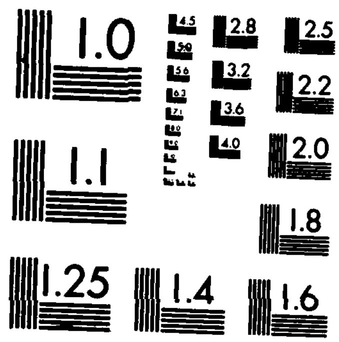
Datum 9.3(f)	Source	Label	Number
If spiral reinforcement is used.	X		
If special conditions are satisfied.	DLT 9.3(e)		
Specified compressive strength of concrete, psi.	X	f'_c	
Gross area of section, sq in.	X	A_g	
Strength reduction factor.	DLT 9.3(d)	ϕ	
Nominal axial load strength at given eccentricity.	X	P_n	
Nominal axial load strength at balanced strain conditions.	X	P_b	

DLT 9.3(f)	Reduction Factor 5	1	2	3	4
C1	Spiral reinforcement?	Y	Y	N	N
C2	Special conditions satisfied?	Y	N	Y	N
A1	$\phi = 0.9 - 1.5\phi P_n/f'_c A_g \geq 0.75$	X			
A2	$\phi = 0.9 - 2\phi P_n/f'_c A_g \geq 0.70$			X	
A3	$\phi = 0.9 - 0.15\phi P_n/\min[.10f'_c A_g, \phi P_b] \geq 0.75$		X		
A4	$\phi = 0.9 - 0.2\phi P_n/\min[.10f'_c A_g, \phi P_b] \geq 0.70$				X
A5	DLT 9.3(g)	X	X	X	X

Comments: 1) DLT 9.3(f) covers part of 9.3.2(c).

2) ACI 318-77 has replaced P_u and P_b in the 1971 Code with ϕP_n and ϕP_b. Now, therefore, the calculation of ϕ is in terms of ϕ; it is not clear, then, how to do this. (Eqs. in A1-A4 above are taken from the Commentary.)

AD-A173 663 COMPUTER-AIDED STRUCTURAL ENGINEERING (CASE) PROJECT · 3/6
DECISION LOGIC TABL (U) ATKINSON-NOLAND & ASSOCIATES
INC BOULDER CO J L NOLAND JUL 86 ATC-TR-86-5-VOL-1
UNCLASSIFIED DACW39-82-M-3741 F/G 9/2 NL



ICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Datum 9.3(g)	Source	Label	Number
ϕ used in design.	X		
Required strength reduction factor.	DLT 9.3(a-f)	ϕ	

DLT 9.3(g) Reduction Factor Check		1	2
C1	ϕ used in design $\leq$ ϕ required?	Y	N
A1	Provision = satisfied	X	
A2	Provision $\neq$ satisfied		X
A3	DLT Ch 9	X	X

Section 9.4 Design Strength for Reinforcement

Datum 9.4(a)	Source	Label	Number
Reinforcement type.	X		
Specified yield strength of nonprestressed reinforcement, psi	X	f_y	

DLT 9.4(a)	Design Strength for Reinforcement	1	2	3	4
C1	Reinforcement type = prestressed?	Y	Y	N	N
C2	Design based on yield strength, f_y, > 80000 psi?	Y	N	Y	N
A1	Provisions = satisfied	X			X
A2	Provisions ≠ satisfied		X	X	
A3	DLT Ch 9	X	X	X	X

Comments: 1) DLT 9.4(a) covers Section 9.4.

2) This Section was interpreted to imply that prestressed reinforcement must have f_y > 8000 psi. It could have been concluded, however, that f_y for prestressed reinforcement could be any value.

Section 9.5 Control of Deflections

Datum 9.5(a)	Source	Label	Number
Member type.	X		
If member is attached to or supporting nonstructural elements likely to be damaged by large deflections.	X		

DLT 9.5(a) Maximum Permitted Computed Deflections		1	2	3	4	5	6	7	
C1	Member type = floor?	Y	Y	Y	N	N	N	N	
C2	Member type = roof?	N	N	N	Y	Y	Y	N	E L S E
C3	Is the member attached to or supporting nonstructural elements likely to be damaged by large deflections?	Y	N	N	Y	N	N		
C4	Is the member attached to or supporting nonstructural elements <u>not</u> likely to be damaged by large deflections?	N	Y	N	N	Y	N		
A1	Maximum immediate deflection due to live load, L, $\le \ell/180$						X		
A2	Maximum immediate deflection due to live load, L, $\le \ell/360$			X					
A3*	Deflection $\le \ell/480$	X			X				
A4*	Deflection $\le \min[\ell/240$, tolerance provided for nonstructural elements$]$		X			X			
A5	No provision, DLT Chapter 9							X	
A6	DLT 9.5(b)	X	X	X	X	X	X		
A7	Logical error								X

Comments:

1) DLT 9.5(a) covers Table 9.5(b).

2) The second footnote to Table 9.5(b) is not needed. If adequate measures are provided, the type of member changes to the last listed in the table (i.e., to C4 above).

---

* That part of the total deflection occurring after attachment of nonstructural elements (sum of the longtime deflection due to all sustained loads and the immediate deflection due to any additional live load).

Datum 9.5(b)	Source	Label	Number
Member type	X		

DLT 9.5(b) Member Type		1	2	3	4	5	
C1	Nonprestressed one-way construction?	Y	N	N	N	N	E
C2	Nonprestressed two-way construction?	N	Y	N	N	N	L
C3	Prestressed construction?	N	N	Y	N	N	S
C4	Composite construction?	N	N	N	Y	N	E
A1	DLT 9.5.2(a)	X					
A2	DLT 9.5.3(a)		X				
A3	DLT 9.5.4(a)			X			
A4	DLT 9.5.5(a)				X		
A5	No provision - DLT Ch 9					X	
A6	Logical error						X

Comment: 1) DLT 9.5(b) is a switching DLT.

Section 9.5.1

This section was not constructed in the DLT format because it was not as significant to the system of DLTs as the other sections.

> 9.5.1 - Reinforced concrete members subject to flexure shall be designed to have adequate stiffness to limit deflections or any deformations that may adversely affect strength or serviceability of a structure at service loads.

Section 9.5.2 One-Way Construction (Nonprestressed)

Datum 9.5.2(a)	Source	Label	Number
If member supports or is attached to partitions or other construction likely to be damaged by large deflections.	X		
If deflections were computed.	X		

DLT 9.5.2(a) One-Way Construction (Nonprestressed)		1	2	3
C1	Is member supporting or attached to partitions or other construction likely to be damaged by large deflections?	I	Y	N
C2	Deflections computed?	Y	N	N
A1	No provisions, DLT Chapter 9		X	
A2	DLT 9.5.2(b)	X		
A3	DLT 9.5.2(i)			X

Comment: 1) DLT 9.5.2(a) partially covers Section 9.5.2.1.

Datum 9.5.2(b)	Source	Label	Number
If immediate deflections were calculated by the usual methods or formulas for elastic deflections considering effects of cracking and reinforcement on member stiffness.	X		
If stiffness was obtained by comprehensive analysis.	X		

DLT 9.5.2(b)	Immediate Deflection 1	1	2	3
C1	Immediate deflections computed by the usual methods or formulas for elastic deflections considering effects of cracking and reinforcement on member stiffness?	Y	Y	N
C2	Stiffness values obtained by comprehensive analysis?	Y	N	I
A1	Provisions = satisfied, DLT 9.5.2(e)	X		
A2	Provisions = satisfied, DLT 9.5.2(c)		X	
A3	Provisions ≠ satisfied, DLT 9.5.2(c)			X

Comment: 1) DLT 9.5.2(b) covers Section 9.5.2.2 and part of Section 9.5.2.3.

Datum 9.5.2(c)	Source	Label	Number
Aggregate type	X		
If f_{ct} is specified and concrete is proportioned in accordance with Section 4.2	X		
Specified concrete strength, psi	X	f'_c	
Average splitting tensile strength of lightweight aggregate concrete, psi	X	f_{ct}	
Ratio of volume of sand replacement to total volume of aggregate	X	r_v	
Weight of concrete, pcf	X	W_c	
Cracking moment	X	M_{cr}	
Maximum moment in member at stage deflection is computed.	X	M_a	
Moment of inertia of gross concrete section about centroidal axis, neglecting reinforcement	X	I_g	
Distance from centroidal axis of gross section, neglecting reinforcement to extreme fiber in tension.	X	y_t	

(Continued)

DLT 9.5.2(c)	Immediate Deflection 2	1	2	3	4	5	
C1	Lightweight aggregate?	Y	Y	Y	Y	N	E
C2	f_{ct} specified and concrete proportioned in accordance with Section 4.2?	Y	N	N	N		L
C3	All-lightweight concrete?		Y	N	N		S
C4	Sand-lightweight concrete?		N	Y	N		E
A1	$f_r = 7.5\sqrt{f'_c}$					X	
A2	$f_r = 7.5 \min[f_{ct}/6.7, \sqrt{f'_c}]$	X					
A3	$f_r = 0.75[7.5\sqrt{f'_c}]$		X				
A4	$f_r = 0.85[7.5\sqrt{f'_c}]$			X			
A5	$f_r = (0.75 + 0.10r_v)[7.5\sqrt{f'_c}]$				X		
A6	$E_c = W_c^{1.5}\ 33\sqrt{f'_c}$	X	X	X	X	X	
A7	$I_e = \min\left\{\left[\left(\frac{M_{CR}}{M_a}\right)^3 I_g + \left[1 - \left(\frac{M_{cr}}{M_a}\right)^3\right] I_{CR}\right], I_g\right\}$ where: $M_{CR} = \frac{f_r I_g}{y_t}$	X	X	X	X	X	
A8	DLT 9.5.2(d)	X	X	X	X	X	
A9	Logical Error						X

Comments: 1) DLT 9.5.2(c) develops the data in Section 9.5.2.3.

2) E_c and I_e are "functions" included here for convenience.

Datum 9.5.2(d)	Source	Label	Number
Modulus of elasticity of concrete, psi.	DLT 9.5.2(c)	E_c	
If immediate deflection was computed using E_c.	X		
If continuous spans.	X		
Effective moment of inertia for computation of deflections.	DLT 9.5.2(c)	I_e	
If immediate deflection was calculated using I_e = average of I_e for the critical positive and negative moment sections.	X		

DLT 9.5.2(d)	Deflection Methods Check	1	2	3	4	5	6	7	8	
C1	Immediate deflections calculated using modulus of elasticity = E_c?	Y	Y	Y	Y	Y	N	N	N	E L S E
C2	Continuous spans?	Y	Y	Y	N	N	Y	Y	N	
C3	Immediate deflection calculated using effective moment of inertia = I_e?	Y	N	N	Y	N	Y	N	I	
C4	Immediate deflection calculated using effective moment of inertia = average of I_e for the critical positive and negative moment sections?	N	Y	N			N	I		
A1	Provisions = satisfied	X	X		X					
A2	Provisions ≠ satisfied			X		X	X	X	X	
A3	DLT 9.5.2(e)	X	X	X	X	X	X	X	X	

Comment:

1) DLT 9.5.2(d) covers Sections 9.5.2.3 and 9.5.2.4.

Datum 9.5.2(e)	Source	Label	Number
If values of long-term deflection were obtained by comprehensive analysis	X		
Value of immediate deflection.	X	δ_i	
Area of nonprestressed tension reinforcement, sq in.	X	A_s	
Area of compression reinforcement, sq in.	X	A'_s	
If the value of long-time deflection was reduced by the amount of deflection calculated to occur before attachment of nonstructural elements.	X		

DLT 9.5.2(e)	Long-Time Deflection - Methods Check	1	2	3	
C1	Values of long-time deflection obtained by comprehensive analysis?	Y	N	N	E
C2	Values of long-time deflection $= \delta_i \left[\max\{[2 - 1.2\ A'_s/A_s], 0.6\}\right]$?	N	Y	N	L S
C3	Value of long-time deflection reduced by the amount of deflection* calculated to occur before attachment of nonstructural elements?	I	I	I	E
A1	Provision = satisfied	X	X		
A2	Provision ≠ satisfied			X	
A3	DLT 9.5.2(f)	X	X	X	
A4	Logical Error				X

Comments:

1) DLT 9.5.2(e) covers Section 9.5.2.5 and the last part of the first sentence of the third footnote to Table 9.5(b).

2) The requirement of C3 above is stated in the third footnote to Table 9.5(b) as optional. However, only this portion of deflection is provided with a limitation in Table 9.5(b).

* This amount shall be determined on the basis of accepted engineering data relating to time-deflection characteristics of members similar to those being considered.

Datum 9.5.2(f)	Source	Label	Number
Computed immediate deflection.	X		
Maximum permitted immediate deflection.	DLT 9.5(a)		
If immediate deflection is due to ponding.	X		

DLT 9.5.2(f) Computed Deflection Check 1		1	2	3
C1	Computed immediate deflection ≤ maximum permitted?	Y	Y	N
C2	Immediate deflection due to ponding?	Y	N	I
A1	Provision = satisfied		X	
A2	Provision ≠ satisfied			X
A3	Deflection limit not intended to safeguard against ponding. DLT 9.5.2(h)	X		
A4	DLT 9.5.2(g)		X	X

Comment: 1) DLT 9.5.2(f) partially covers Section 9.5.2.6.

Datum 9.5.2(g)	Source	Label	Number
That part of the total deflection occurring after attachment of non-structural elements (sum of the long-time deflection due to all sustained loads and the immediate deflection due to any additional live load).	X		
Maximum deflection permitted.	DLT 9.5(a)		

	DLT 9.5.2(g) Computed Deflection Check 2	1	2	3
C1	That part of the total deflection occurring after attachment of nonstructural elements (sum of the long-time deflection due to all sustained loads and the immediate deflection due to any additional live load) $\leq$ maximum permitted?	Y	N	N
C2	Roof or floor construction supporting or attached to nonstructural elements <u>not</u> likely to be damaged by large deflections and with camber provided so that total deflection minus camber $\leq$ maximum permitted?	I	Y	N
A1	Provision = satisfied	X	X	
A2	Provision $\neq$ satisfied			X
A3	DLT 9.5.2(i)	X	X	X

Comment: 1) DLT 9.5.2(g) partially covers Section 9.5.2.6 and incorporates part of the fourth footnote to Table 9.5(b).

Datum 9.5.2(h)	Source	Label	Number
Method of checking for ponding.	X		

DLT 9.5.2(h)	Computed Deflection Check 3	1	2
C1	Ponding checked by suitable calculations of deflection, including added deflections due to ponded water, and long-time effects of all sustained loads, camber, construction tolerances, and reliability of provisions for drainage considered?	Y	N
A1	Provision = satisfied	X	
A2	Provision ≠ satisfied		X
A3	DLT 9.5.2(i)	X	X

Comment: 1) DLT 9.5.2(h) partially covers the first footnote to Table 9.5(b).

Datum 9.5.2(i)	Source	Label	Number
Member type.	X		
End conditions.	X		

DLT 9.5.2(i)	Minimum Thickness 1	1	2	3	4	5	6	7	8	
C1	Solid one-way slab?	Y	Y	Y	Y	N	N	N	N	
C2	Beam or ribbed one-way slab?	N	N	N	N	Y	Y	Y	Y	E
C3	Simply supported?	Y	N	N	N	Y	N	N	N	L
C4	One end continuous?	N	Y	N	N	N	Y	N	N	S
C5	Both ends continuous?	N	N	Y	N	N	N	Y	N	E
C6	Cantilever?	N	N	N	Y	N	N	N	Y	
A1	$\overline{h} = \ell/20$	X								
A2	$\overline{h} = \ell/24$		X							
A3	$\overline{h} = \ell/28$			X						
A4	$\overline{h} = \ell/10$				X					
A5	$\overline{h} = \ell/16$					X				
A6	$\overline{h} = \ell/18.5$						X			
A7	$\overline{h} = \ell/21$							X		
A8	$\overline{h} = \ell/8$								X	
A9	DLT 9.5.2(j)	X	X	X	X	X	X	X	X	
A10	Logical Error									X

Comments: 1) DLT 9.5.2(i) covers the body of Table 9.5(a)

2) This DLT, as does Table 9.5(a), shows that only the member types and end conditions treated are possible.

Datum 9.5.2(j)	Source	Label	Number
Concrete density, pcf.	X	w_c	
Yield stress of reinforcement.	X	f_y	
Basic allowable thickness.	DLT 9.5.2(a)	$\overline{h}$	

DLT 9.5.2(j)	Minimum Thickness 2	1	2	3	4	5	
C1	$120 < w_c \leq 145$ pcf?	Y	Y	N	N	N	E L S E
C2	$90 \leq w_c \leq 120$ pcf?	N	N	Y	Y	N	
C3	$f_y = 60000$ psi?	Y	N	Y	N	I	
A1	Minimum thickness (h) = $\overline{h}$	X					
A2	Minimum thickness (h) $= \max[(1.65 - 0.005w_c), 1.09]\overline{h}$			X			
A3	Minimum thickness (h) = $(0.4 + f_y/100{,}000)\overline{h}$		X				
A4	Minimum thickness (h) $= \{\max[(1.65 - .005w_c), 1.09]\ (0.4 + f_y/100000)\overline{h}\}$				X		
A5	No provision					X	
A6	DLT 9.5.2(k)	X	X	X	X	X	
A7	Logical Error						X

Comment: 1) DLT 9.5.2(j) covers the footnotes to Table 9.5(a).

Datum 9.5.2(k)	Source	Label	Number
Actual thickness.	X		
Minimum thickness.	DLT 9.5.2 (j)	h	
If computation of deflection indicates a thickness less than minimum thickness may be used without adverse effects.	X		

DLT 9.5.2(k) Thickness Check		1	2	3
C1	Actual thickness $\geq$ h?	Y	N	N
C2	Computation of deflection indicates a thickness less than h may be used without adverse effects?	I	Y	N
A1	Provisions = satisfied	X	X	
A2	Provisions $\neq$ satisfied			X
A3	DLT Ch 9	X	X	X

Comment: 1) DLT 9.5.2(k) covers the last phase of Section 9.5.2.1.

Section 9.5.3 Two-Way Construction (Nonprestressed)

Datum 9.5.3(a)	Source	Label	Number
If deflections were computed.	X		

DLT 9.5.3(a) Switching		1	2
C1	Were deflections computed?	Y	N
A1	DLT 9.5.3(b)	X	
A2	DLT 9.5.3(h)		X

Comment:

1) If deflections are not computed, minimum thicknesses control.

Datum 9.5.3(b)	Source	Label	Number
If immediate deflections were computed <u>and</u> considerations considered.	X		
Value of modulus of elasticity used.	X		
Value of modulus of elasticity specified by Code.	DLT 9.5.2(c)	E_c	

DLT 9.5.3(b)	Computation Method Check 1	1	2	3
C1	Immediate deflections computed taking into account size and shape of panel, conditions of support, and nature of restraints at edges?	Y	Y	N
C2	Value of modulus of elasticity used = E_c?	Y	N	I
A1	Provisions = satisfied.	X		
A2	Provisions ≠ satisfied.		X	X
A3	DLT 9.5.3(c)	X	X	X

Comments: 1) DLT 9.5.3(b) partially covers Section 9.5.3.4.

2) The stipulations regarding deflections stated in the second, third, and fourth sentences of Section 9.5.3.4 are assumed to apply to <u>immediate</u> deflections. It is not specifically stated.

Datum 9.5.3(c)	Source	Label	Number
Value of effective moment of inertia used.	X		
Value of effective moment of inertia required.	DLT 9.5.2(c)	I_e	
If computed deflection is in reasonable agreement with comprehensive tests.	X		

DLT 9.5.3(c)	Computation Method Check 2	1	2
C1	Value of effective moment of inertia = I_e?	I	I
C2	Computed deflection in reasonable agreement with results of comprehensive tests?	Y	N
A1	Provisions = satisfied	X	
A2	Provisions ≠ satisfied		X
A3	DLT 9.5.3(d)	X	X

Comments:

1) DLT 9.5.3(c) partially covers Section 9.5.3.4.

2) The terms "reasonable agreement" and "comprehensive tests" are not defined in the Code.

Datum 9.5.3(d)	Source	Label	Number
If values of long-time deflections were obtained by comprehensive analysis.	X		
Value of immediate deflection.	X	δ_i	
Area of nonprestressed tension reinforcement, sq in.	X	A_R	
Area of compression reinforcement, sq in.	X	A_s'	
If the value of long-time deflection was reduced by the amount of deflection calculated to occur before attachment of nonstructural elements.	X		

DLT 9.5.3(d)	Long-Time Deflection - Methods Check	1	2	3	
C1	Values of long-time deflection obtained by comprehensive analysis?	Y	N	N	E
C2	Values of long-time deflection $= \delta_i\left[\max\left\{[2 - 1.2A_s'/A_s], 0.6\right\}\right]$?	N	Y	N	L S
C3	Value of long-time deflection reduced by the amount of deflection* calculated to occur before attachment of nonstructural elements?	I	I	I	E
A1	Provisions = satisfied	X	X		
A2	Provisions ≠ satisfied			X	
A3	DLT 9.5.3(e)	X	X	X	
A4	Logical Error				X

Comments:

1) DLT 9.5.3(d) covers Section 9.5.2.5 and the last part of the first sentence of the third footnote to Table 9.5(b).

2) The requirement of C3 above is stated in the third footnote to Table 9.5(b) as optional. However, only this portion of deflection is provided with a limitation in Table 9.5(b).

---

* This amount shall be determined on the basis of accepted engineering data relating to time-deflection characteristics of members similar to those being considered.

Datum 9.5.3(e)	Source	Label	Number
Computed immediate deflection.	X		
Maximum permitted immediate deflection.	DLT 9.5(a)		
If immediate deflection is due to ponding.	X		

DLT 9.5.3(e)	Deflection Check 1	1	2	3
C1	Computed immediate deflection $\leq$ maximum permitted?	Y	Y	N
C2	Immediate deflections due to ponding?	Y	N	I
A1	Provisions = satisfied		X	
A2	Provisions ≠ satisfied			X
A3	Deflection limit not intended to safeguard against ponding. DLT 9.5.3(g)	X		
A4	DLT 9.5.3(f)		X	X

Comment: 1) DLT 9.5.3(e) partially covers Section 9.5.3.4.

Datum 9.5.3(f)	Source	Label	Number
That part of the total deflection occurring after attachment of non-structural elements (sum of the long-time deflection due to all sustained loads and the immediate deflection due to any additional live load.	X		
Maximum deflection permitted.	DLT 9.5(a)		

	DLT 9.5.3(f) Computed Deflection Check 2	1	2	3
C1	That part of the total deflection occurring after attachment of nonstructural elements (sum of the long-time deflection due to all sustained loads and the immediate deflection due to any additional live load) $\leq$ maximum permitted?	Y	N	N
C2	Roof or floor construction supporting or attached to nonstructural elements not likely to be damaged by large deflections <u>and</u> with camber provided so that total deflection minus camber $\leq$ maximum permitted?	I	Y	N
A1	Provision = satisfied	X	X	
A2	Provision $\neq$ satisfied			X
A3	DLT 9.5.3(h)	X	X	X

Comment:

1) DLT 9.5.3(f) partially covers Section 9.5.3.4 and incorporates part of the fourth footnote to Table 9.5(b).

Datum 9.5.3(g)	Source	Label	Number
Method of checking for ponding.	X		

DLT 9.5.3(g)	Computed Deflection Check 3	1	2
C1	Ponding checked by suitable calculations of deflection, including added deflections due to ponded water and long-time effects of all sustained loads, camber, construction tolerances, and reliability of provisions for drainage considered?	Y	N
A1	Provision = satisfied	X	
A2	Provision ≠ satisfied		X
A3	DLT 9.5.2(i)	X	X

Comments:

1) DLT 9.5.2(g) partially covers the first footnote to Table 9.5(b).

2) C1 above is a very complex condition which could be expanded into several.

Datum 9.5.3(h)	Source	Label	Number
If designed in accordance with provisions of Ch 13.	X		
Ratio of long-to-short span.	X		
Length of clear span in long direction of two-way construction measured face-to-face of supports in slabs without beams and face-to-face or other supports in other cases.	X	ℓ_n	
Specified yield strength of non-prestressed reinforcement.	X	f_y	
Ratio of clear spans in long to short direction of two-way slabs.	X	β	
Ratio of length of continuous edges to total perimeter of slab.	X	β_s	

DLT 9.5.3(h)	Two-Way Minimum Thickness 1	1	2	3
C1	Designed in accordance with the provisions of Ch 13?	Y	Y	N
C2	Ratio of long-to-short span $\leq$ 2?	Y	N	I
A1	$\bar{h} = h_3$ where: $h_1 \leq h_3 \leq h_2$ and $h_1 = \dfrac{\ell_n(800 + 0.005f_y)}{36000 + 5000\beta(1 + \beta_s)}$ $h_2 = \dfrac{\ell_n(800 + 0.005f_y)}{36000}$ $h_3 = \dfrac{\ell_n(800 + 0.005f_y)}{36000 + 5000\beta\left[\alpha_m - 0.5(1 - \beta_s)(1 + \frac{1}{\beta})\right]}$			
A2	No provision, DLT Ch 9		X	X
A3	DLT 9.5.3(i)	X		

Comment: 1) DLT 9.5.3(h) partially covers Section 9.5.3.1.

Datum 9.5.3(i)	Source	Label	Number
If member is a slab without drop panels or beams.	X		
If member is a slab without beams, but with drop panels.	X		
If member is a slab having beams on all four edges with a value of $\alpha_m \geq 2$.	X		

DLT 9.5.3(i)	Two-Way Minimum Thickness 2	1	2	3	4	
C1	Member type = slab without drop panels or beams?	Y	N	N	N	E
C2	Member type = slab without beams, but with drop panels?	N	Y	N	N	L
						S
C3	Member Type = slab having beams on all four edges with a value of $\alpha_m \geq 2.0$?	N	N	Y	N	E
A1	$h = \max[\bar{h}, 5 \text{ in.}]$	X				
A2	$h = \max[\bar{h}, 3\frac{1}{2} \text{ in.}]$			X		
A3	$h = \bar{h}$				X	
A4	DLT 9.5.3(j)		X			
A5	DLT 9.5.3(k)	X		X	X	
A6	Logical Error					X

Comments:

1) DLT 9.5.3(i) covers parts (a), (b), and (c) of Section 9.5.3.1.

2) It is assumed that for member types not listed that minimum thickness is given by Eqs. (9-10), (9-11), and (9-12) without restrictions.

Datum 9.5.3(j)	Source	Label	Number
If drop panels extend in each direction from centerline of support a distance $\geq$ 1/6 the span length in that direction measured center-to-center of supports.	X		
If drop panels project below the slab $\geq$ 1/4 the slab thickness beyond the drop.	X		
Basic required thickness	DLT 9.5.3(h)	$\bar{h}$	

DLT 9.5.3(j)	Two-Way Minimum Thickness 3	1	2	3
C1	Do drop panels extend in each direction from centerline of support a distance $\geq$ 1/6 the span length in that direction measured center-to-center of supports?	Y	Y	N
C2	Does drop panel project below the slab $\geq$ 1/4 the slab thickness beyond the drop?	Y	N	I
A1	$h = \max[.90\bar{h}, 4 \text{ in.}]$	X		
A2	$h = \max[\bar{h}, 4 \text{ in.}]$		X	X
A3	DLT 9.5.3(k)	X	X	X

Comments:

1) DLT 9.5.3(j) covers Section 9.5.3.2.

2) It is assumed that the provisions (a), (b), and (c) of Section 9.5.3.1 apply to Section 9.5.3.2.

Datum 9.5.3(k)	Source	Label	Number
Thickness provided.	X		
Minimum thickness.	DLT 9.5.3(i,j)	h	

DLT 9.5.3(k) Thickness Check		1	2
C1	Thickness provided $\geq$ h?	Y	N
A1	Provisions = satisfied	X	
A2	Provisions $\neq$ satisfied		X
A3	DLT Ch 9	X	X

Section 9.5.4 Prestressed Concrete Construction

Datum 9.5.4(a)	Source	Label	Number
If member is flexural member designed in accordance with provisions of Chapter 18.	X		
If deflection was computed by usual methods or formulas for elastic deflections.	X		

DLT 9.5.4(a) Prestressed Concrete 1		1	2	3	
C1	Flexural member designed in accordance with provisions of Chapter 18?	Y	Y	N	E
C2	Deflection computed by usual methods or formulas for elastic deflections?	Y	N		L S
C3	Moment of inertia of the gross concrete section used for uncracked sections?	I	I		E
A1	Provisions = satisfied	X			
A2	Provisions ≠ satisfied		X		
A3	No provision, DLT Chapter 9			X	
A4	DLT 9.5.4(b)	X	X		
A5	Logical Error				X

Comments:

1) DLT 9.5.4(a) covers Section 9.5.4.1.

2) It is assumed that Section 9.5.4 applies only to flexural members designed in accordance with Chapter 18.

Datum 9.5.4(b)	Source	Label	Number
If additional long-time deflection was computed.	X		
If stresses in concrete and steel under sustained load were considered.	X		
If effects of creep and shrinkage and relaxation of steel were considered.	X		

DLT 9.5.4(b) Prestressed Concrete 2		1	2	3
C1	Additional long-time deflection computed?	Y	Y	N
C2	Stresses in concrete and steel under sustained load including effects of creep and shrinkage <u>and</u> relaxation of steel considered?	Y	N	I
A1	Provisions = satisfied	X		
A2	Provisions ≠ satisfied		X	X
A3	DLT 9.5.4(c)	X	X	X

Comment: 1) DLT 9.5.4(b) covers Section 9.5.4.2.

Datum 9.5.4(c)	Source	Label	Number
Computed deflection.	X		
Maximum allowable deflection.	DLT 9.5(a)		

DLT 9.5.4(c)	**Prestressed Concrete 3**	1	2
C1	**Deflection computed $\leq$ maximum allowable?**	Y	N
A1	**Provisions = satisfied**	X	
A2	**Provisions $\neq$ satisfied**		X
A3	DLT Chapter 9	X	X

Comment:

1) DLT 9.5.4(c) covers Section 9.5.4.3.

Section 9.5.5 Composite Construction

Datum 9.5.5(a)	Source	Label	Number
If construction is shored.	X		

DLT 9.5.5(a) Shoring State		1	2
C1	Shored construction?	Y	N
A1	DLT 9.5.5(b)	X	
A2	DLT 9.5.5(f)		X

Comment:

1) DLT 9.5.5(a) is a switching DLT.

Datum 9.5.5(b)	Source	Label	Number
If deflection was computed.	X		
If the flexural member was supported during construction so that, after removal of temporary supports, dead load is resisted by the full composite section .	X		
If the composite member is considered equivalent to a monolithically cast member.	X		
If account was taken of curvatures resulting from differential shrinkage of precast and cast-in-place components.	X		

DLT 9.5.5(b) Shored Construction 1		1	2	3	4	5	6	
C1	Deflection computed?	Y	Y	Y	Y	Y	N	
C2	Flexural member supported during construction so that, after removal of temporary supports, dead load is resisted by the full composite section?	Y	Y	N	N	N		ELSE
C3	Composite member considered equivalent to a monolithically case member?	I	I	Y	N	N		
C4	Account taken of curvatures resulting from differential shrinkage of precast and cast-in-place components?	Y	N	I	Y	N		
A1	Provisions = satisfied	X			X			
A2	Provisions ≠ satisfied		X	X		X		
A3	DLT 9.5.5(c)	X	X	X	X	X		
A4	DLT 9.5.5(e)						X	
A5	Logical Error							X

Comment: 1) DLT 9.5.5(b) partially covers Section 9.5.5.1.

Datum 9.5.5(c)	Source	Label	Number
Member type.	X		
If account was taken of creep effects.	X		

DLT 9.5.5(c)	Shored Construction 2	1	2	3
C1	Prestressed member?	Y	Y	N
C2	Account taken of creep effects?	Y	N	I
A1	Provisions = satisfied	X		
A2	Provisions ≠ satisfied		X	
A3	DLT 9.5.5(d)	X	X	X

Comment: 1) DLT 9.5.5(c) partially covers Section 9.5.5.1.

Datum 9.5.5(d)	Source	Label	Number
Computed deflection.	X		
Maximum allowable deflection.	DLT 9.5(a)		

DLT 9.5.5(d) Deflection Check		1	2
C1	Computed deflection $\leq$ maximum allowable?	Y	N
A1	Provisions = satisfied	X	
A2	Provisions $\neq$ satisfied		X
A3	DLT Ch 9	X	X

Comment: 1) DLT 9.5.5(d) covers Section 9.5.5.3 as it applies to shored construction.

Datum 9.5.5(e)	Source	Label	Number
Actual thickness.	X		
Minimum thickness.	DLT 9.5.2(j)		

DLT 9.5.5(e) Thickness Check		1	2
C1	Actual thickness $\geq$ minimum thickness*?	Y	N
A1	Provisions = satisfied	X	
A2	Provisions $\neq$ satisfied		X
A3	DLT Chapter 9	X	X

Comments:

1) DLT 9.5.5(e) covers the thickness check implied in Section 9.5.5.1.

2) The provisions of Section 9.5.5 are presented in the Code as equal-level with Sections 9.5.2 and 9.5.3. It appears that they really are special cases and subordinate, however.

* The portion of the member in compression shall determine the value of concrete unit weight used in DLT 9.5.2(j).

Datum 9.5.5(f)	Source	Label	Number
Member type.	X		
If deflection was computed.	X		
Actual thickness.	X		
Minimum thickness	DLT 9.5.2(j)		
Maximum deflection allowed.	DLT 9.5(a)		
Long-time deflection due to magnitude and duration of load prior to the beginning of effective composite action.	X		

DLT 9.5.5(f)	Unshored Construction 1	1	2	3	4	5	6	
C1	Member type = flexural, non-prestressed, precast?	Y	Y	Y	Y	Y	N	E
C2	Deflection computed?	Y	Y	N	N	N		L
C3	Thickness $\geq$ minimum thickness?	I	I	Y	Y	N		S
C4	Long-time deflection due to magnitude and duration of load prior to beginning of effective composite action $\leq$ maximum allowed?	Y	N	Y	N	I		E
A1	Provisions = satisfied	X		X				
A2	Provisions $\neq$ satisfied		X		X	X		
A3	DLT Chapter 9	X	X	X	X	X		
A4	DLT 9.5.5(g)						X	
A5	Logical Error							X

Comments:

1) DLT 9.5.5(f) partially covers Section 9.5.5.2 and Section 9.5.5.3 as it applies to unshored construction.

2) The Code distinguishes between precast flexural members and composite members in the first sentence of Section 9.5.5.2 and the first two phrases of the second sentence. The last phrase of the second sentence, however, refers to composite action of precast members, which seems ambiguous.

Datum 9.5.5(g)	Source	Label	Number
Member type.	X		
Thickness.	X		
Minimum allowable thickness	DLT 9.5.2(j)		
If deflection after member becomes composite computed.	X		
Computed deflection.	X		
Maximum allowable deflection.	DLT 9.5(a)		

	DLT 9.5.5(g) Unshored Construction 2	1	2	3	4	5	
C1	Member type = non-prestressed, composite?	Y	Y	Y	Y	N	E
C2	Thickness $\geq$ minimum?	I	I	Y	N		L
C3	Deflection occurring after member becomes composite computed?	Y	Y	N	N		S
C4	De ction computed $\leq$ maximum allowed?	Y	N				E
A1	Provisions = satisfied	X		X			
A2	Provisions $\neq$ satisfied		X		X		
A3	No provision					X	
A4	DLT Ch 9	X	X	X	X	X	
A5	Logical Error						X

Comments: 1) DLT 9.5.5(g) partially covers Section 9.5.5.2 and Section 9.5.5.3 as it applies to unshored construction.

2) See Comment 2 to DLT 9.5.5(f).

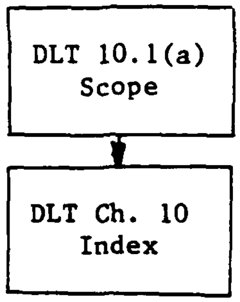
ACI CHAPTER 10: FLEXURE AND AXIAL LOADS

DLT Chapter 10-1		1	2	3	4	5	6	7	
C1	Scope?	Y	N	N	N	N	N	N	
C2	Design assumptions?	N	Y	N	N	N	N	N	E
C3	General principles and requirements?	N	N	Y	N	N	N	N	L
C4	Distance between lateral supports of flexural members?	N	N	N	Y	N	N	N	S E
C5	Minimum reinforcement of flexural members?	N	N	N	N	Y	N	N	
C6	Distribution of flexural reinforcement in beams and one-way slabs?	N	N	N	N	N	Y	N	
A1	Section 10.1	X							
A2	Section 10.2		X						
A3	Section 10.3			X					
A4	Section 10.4				X				
A5	Section 10.5					X			
A6	Section 10.6						X		
A7	DLT Chapter 10-2							X	
A8	Logical Error								X

DLT Chapter 10-2		1	2	3	4	5	6	
C7	Deep flexural members?	Y	N	N	N	N	N	
C8	Design dimensions for compression members?	N	Y	N	N	N	N	E
								L
C9	Limits of reinforcement of compression members?	N	N	Y	N	N	N	S
C10	Slenderness effects in compression members?	N	N	N	Y	N	N	E
C11	Approximate evaluation of slenderness effects?	N	N	N	N	Y	N	
A9	Section 10.7	X						
A10	Section 10.8		X					
A11	Section 10.9			X				
A12	Section 10.10				X			
A13	Section 10.11					X		
A14	DLT Ch 10-3						X	
A15	Logical Error							X

DLT Chapter 10-3		1	2	3	4	5	6	
C12	Axially loaded member supporting slab system?	Y	N	N	N	N	N	E
C13	Transmission of column loads through floor system?	N	Y	N	N	N	N	L
C14	Composite compression members?	N	N	Y	N	N	N	S
C15	Special provisions for walls?	N	N	N	Y	N	N	E
C16	Bearing strength?	N	N	N	N	Y	N	
A16	Section 10.12	X						
A17	Section 10.13		X					
A18	Section 10.14			X				
A19	Section 10.15				X			
A20	Section 10.16					X		
A21	DLT 318-77 Index						X	
A22	Logical Error							X

Section 10.1 Map



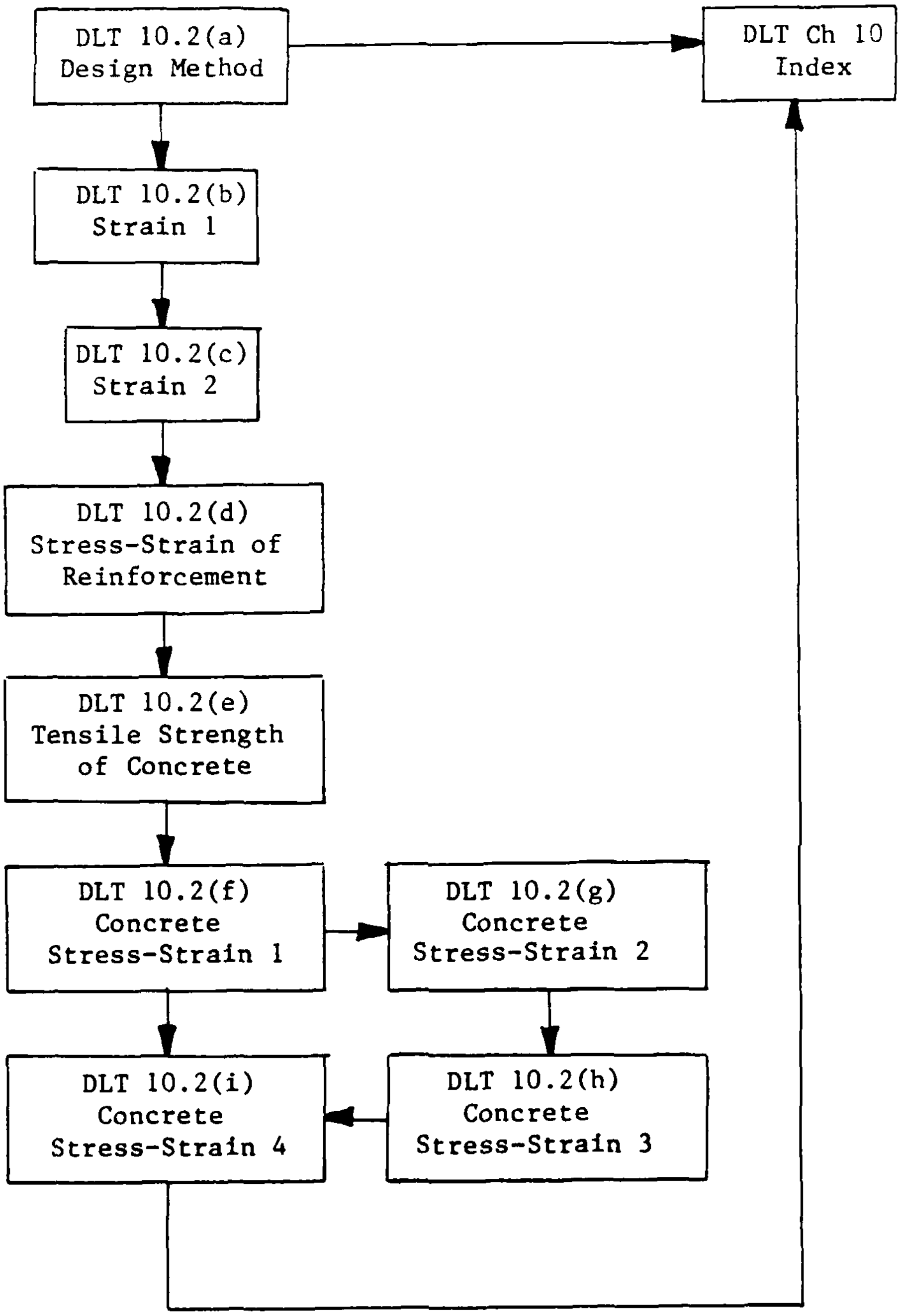
Section 10.1 Scope

Datum 10.1(a)	Source	Label	Number
Load type.	X		

DLT 10.1(a) Scope		1	2	3
C1	Member subject to axial load?	Y	N	N
C2	Member subject to flexure?	I	Y	N
A1	Provisions of Ch 10 apply	X	X	
A2	Provisions of Ch 10 do not apply			X
A3	DLT Ch 10	X	X	X

Comment: 1) DLT 10.1(a) covers Section 10.1.

Section 10.2 Map



Section 10.2 Design Assumptions

Datum 10.2(a)	Source	Label	Number
Design method.	X		

DLT 10.2(a)	Design Method	1	2
C1	Strength method of design?	Y	N
A1	Design assumptions of Section 10.2 apply	X	
A2	Design assumptions of Section 10.2 do not apply		X
A3	DLT 10.2(b)	X	
A4	DLT Chapter 10		X

Comment:

1) DLT 10.2(a) covers Section 10.2.1 with respect to design method. The rest of Section 10.2.1 is covered implicitly in the balance of Section 10.2.

Datum 10.2(b)	Source	Label	Number
Member type.	X		
Depth to clear span ratio.	X		
Type of span.	X		
Strain distribution assumption.	X		

DLT 10.2(b) Strain 1		1	2	3	4	
C1	Flexural member with overall depth to clear span ratio > 2/5 for continuous spans or > 4/5 for simple spans?	Y	Y	N	N	E L
C2	Strain assumed proportional to distance from neutral axis?	Y	N	Y	N	S
C3	Nonlinear strain distribution used?	N	Y	N	Y	E
A1	Provisions = satisfied		X	X		
A2	Provisions ≠ satisfied	X			X	
A3	DLT 10.2(c)	X	X	X	X	
A4	Logical Error					X

Comments: 1) DLT 10.2(b) covers Section 10.2.2.

2) A separate DLT could be written to handle the logic in C1.

Datum 10.2(c)	Source	Label	Number
Usable strain at extreme concrete compression fiber.	X		

DLT 10.2(c) Strain 2		1	2
C1	Usable strain at extreme concrete compression fiber < 0.003?	Y	N
A1	Provisions = satisfied	X	
A2	Provisions ≠ satisfied		X
A3	DLT 10.2(d)	X	X

Comment: 1) DLT 10.2(c) covers Section 10.2.3.

Datum 10.2(d)	Source	Label	Number
Strain in tension reinforcement at a stress less than yield.	X	ε_s	
Strain in tension reinforcement at a stress equal to yield.	X	ε_y	
Specified yield strength of non-prestressed reinforcement, psi.	X	f_y	
Calculated stress in reinforcement at service load, psi.	X	f_s	
Modulus of elasticity of reinforcement, psi.	X	E_s	

DLT 10.2(d)	Stress-Strain of Reinforcement	1	2	3	4	
C1	$\varepsilon_s < \varepsilon_y$?	Y	Y	N	N	ELSE
C2	$f_s = \varepsilon_s E_s$?	Y	N	I	I	
C3	$f_s = f_y$?	N	N	N	Y	
A1	Provisions = satisfied	X			X	
A2	Provisions ≠ satisfied		X	X		
A3	DLT 10.2(e)	X	X			
A4	Logical Error					X

Comments: 1) DLT 10.2(d) covers Section 10.2.4.

2) In accordance with the Commentary and Code, this DLT ignores strain hardening.

Datum 10.2(e)	Source	Label	Number
If tensile strength is included in calculations of reinforced concrete.	X		
If tensile strength is in accordance with requirements of Section 18.4.	X		

DLT 10.2(e)	Tensile Strength of Concrete	1	2	3
C1	Tensile strength of concrete included in flexural calculations of reinforced concrete?	Y	Y	N
C2	Tensile strength meets requirements of Section 18.4?	Y	N	I
A1	Provisions = satisfied	X		X
A2	Provisions ≠ satisfied		X	
A3	DLT 10.3(f)	X	X	X

Comments: 1) DLT 10.2(e) covers Section 10.2.5.

2) The phraseology of Section 10.2.5 is such that one could infer that tensile strength of concrete <u>must</u> be considered if requirements of Section 18.4 are met. As reflected in decision rule #3, it was assumed here that C2 does not apply if the response to C1 is negative.

Datum 10.2(f)	Source	Label	Number
Shape of stress-strain relationship of concrete.	X		

DLT 10.2(f) Concrete Stress-Strain 1		1	2
C1	Shape of concrete stress-strain relationship equal rectangular?	Y	N
A1	DLT 10.2(g)	X	
A2	DLT 10.2(i)		X

Comment: 1) DLT 10.2(f) relates to Sections 10.2.6 and 10.2.7.

Datum 10.2(g)	Source	Label	Number
Specified compressive strength of concrete, psi.	X	f'_c	

DLT 10.2(g)	Concrete Stress-Strain 2	1	2
C1	$f'_c \leq 4000$ psi?	Y	N
A1	$\beta_1 = 0.85$	X	
A2	$\beta_1 = \max\left[0.85 - \frac{(f'_c - 4000)}{1000}(.05),\ 0.65\right]$		X
A3	DLT 10.2(h)	X	X

Comment: 1) DLT 10.2(g) covers Section 10.2.7(c).

Datum 10.2(h)	Source	Label	Number
Factor.	DLT 10.2(g)	β_1	
Specified compressive strength of concrete, psi.	X	f'_c	
Distance from extreme compression fiber to neutral axis, in.	X	c	

	DLT 10.2(h) Concrete Stress-Strain 3	1	2	3
C1	Concrete stress = 0.85 f'_c assumed uniformly distributed over an equivalent compression zone bounded by edges of the cross section and a straight line located parallel to the neutral axis at a distance $a = \beta_1 c$ from the fiber of maximum compression strain?	Y	Y	N
C2	Distance, c, from the fiber of maximum strain to neutral axis measured in a direction perpendicular to the neutral axis?	Y	N	I
A1	Provisions = satisfied	X		
A2	DLT Ch 10	X		
A3	Provisions ≠ satisfied		X	X
A4	DLT 10.2(i)		X	X

Comments: 1) DLT 10.2(h) covers Sections 10.2.7(a),(b).

2) The requirements in Section 10.2.7 are applicable to a specific rectangular stress distribution. Others may be satisfactory. Therefore, the user is transferred to DLT 10.2(i) in decision rules 2 and 3.

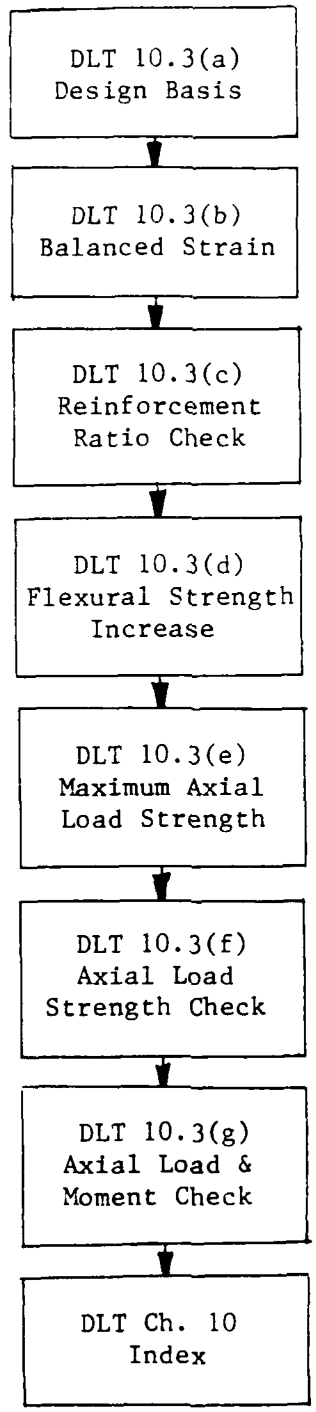
Datum 10.2(i)	Source	Label	Number
Shape of concrete stress-strain relationship assumed.	X		
If shape results in prediction of strength in substantial agreement with results of comprehensive tests.	X		

	DLT 10.2(i) Concrete Stress-Strain 4	1	2
C1	Relationship between concrete compressive stress distribution and concrete strain approximated by a shape that results in substantial agreement with results of compressive tests?	Y	N
C2	Shape of distribution equal rectangular, trapazoidal or parabolic?	I	I
A1	Provisions = satisfied	X	
A2	Provisions ≠ satisfied		X
A3	DLT Ch 10	X	X

Comments: 1) DLT 10.2(i) covers Section 10.2.6.

2) "Substantial agreement with results of compressive tests" is not defined.

Section 10.3 Map



Section 10.3 General Principles and Requirements

Datum 10.3(a)	Source	Label	Number
Design loads on cross section.	X		
If design is based on stress and strain compatibility using assumptions of Section 10.2.	X		

DLT 10.3(a) Design Basis		1	2	3	
C1	Cross section subject to flexure or axial loads or to combined flexure and axial load?	Y	Y	N	ELSE
C2	Design based on stress and strain compatibility using assumptions of Section 10.2?	Y	N		
A1	Provision = satisfied	X			
A2	Provisions ≠ satisfied		X		
A3	DLT 10.3(b)	X	X		
A4	No provisions - DLT Ch 10			X	
A5	Logical Error				X

Comment: 1) DLT 10.3(a) covers Section 10.3.1.

Datum 10.3(b)	Source	Label	Number
Strain in tension reinforcement at a stress less than yield.	X	ε_s	
Strain in tension reinforcement at stress equal yield.	X	ε_y	
Strain in concrete.	X	ε_c	

DLT 10.3(b) Balanced Strain		1	2	3
C1	$\varepsilon_s = \varepsilon_y$?	Y	Y	N
C2	$\varepsilon_c = 0.003$?	Y	N	I
A1	Balanced strain condition	X		
A2	DLT 10.3(c)	X	X	X

Comments: 1) DLT 10.3(b) covers Section 10.3.2.

2) This DLT merely defines the balanced strain condition.

Datum 10.3(c)	Source	Label	Number
Nominal axial load strength at a given eccentricity.	X	ϕP_n	
Strength reduction factor.	X	ϕ	
Specified strength of concrete, psi.	X	f'_c	
Gross area of section, sq in.	X	A_g	
Nominal axial load strength at balanced strain condition.	X	P_b	
Ratio of non-prestressed tension reinforcement provided.	X	ρ	
Balanced reinforcement ratio for a rectangular section with tension reinforcement only and zero axial load.	X	$\bar{\rho}_b$	
Reinforcement ratio producing balanced conditions.	X	ρ_b	

(Continued)

DLT 10.3(c) Reinforcement Ratio Check		1	2	3	4	5	
C1	$\phi P_n \leq \min[.10 f'_c A_g, \phi P_b]$?	Y	Y	Y	Y	N	
C2	Compression reinforcement used?	Y	Y	N	N		E
C3	$\rho \leq 0.75\ \rho_b$?			Y	N		L
C4	The portion of ρ_b equalized by the compression reinforcement reduced by the 0.75 factor?	I	I				S E
C5	Is $\bar{\rho}_b$ reduced by the 0.75 factor?	Y	N				
A1	Provisions = satisfied	X		X			
A2	Provisions ≠ satisfied		X		X		
A3	No provision					X	
A4	DLT 10.3(d)	X	X	X	X	X	
A5	Logical Error						X

Comments: 1) DLT 10.3(c) covers Section 10.3.3.

2) For sections designed for flexure only, $\phi P_n = 0$.

3) In accordance with the Commentary, ρ_b is used here as a general term which is comprised of two parts, i.e., $\rho_b = f(\bar{\rho}_b)$ + another term if the section is flanged or if compression reinforcement is present.

4) Note that $\bar{\rho}_b$ is based on zero axial load. This is implied in the commentary.

5) This Section of the Code could be revised to be more specific and consistent with the Commentary.

Datum 10.3(d)	Source	Label	Number
Use of compression reinforcement in conjunction with additional tension reinforcement to increase the strength of flexural members.	X		

DLT 10.3(d)	Flexural Strength Increase	1
C1	Compression reinforcement used in conjunction with additional tension reinforcement to increase the strength of flexural members?	I
A1	Provision = satisfied	X
A2	DLT 10.3(c)	X

Comments:

1) DLT 10.3(d) covers Section 10.3.4.
2) The provision is optional.

Datum 10.3(e)	Source	Label	Number
Member type.	X		
Type of lateral reinforcement.	X		
Specified strength of concrete, psi.	X	f'_c	
Gross area of section, sq in.	X	A_g	
Total area of longitudinal reinforcement, sq in.	X	A_{st}	
Strength reduction factor.	X	ϕ	
Nominal axial load strength at zero eccentricity.	X	P_o	

DLT 10.3(e)	Maximum Axial Load Strength	1	2	3	4	
C1	Prestressed member?	Y	Y	N	N	E L S E
C2	Spiral lateral reinforcement?	Y	N	Y	N	
C3	Tie lateral reinforcement?	N	Y	N	Y	
A1	$\phi P_{n(max)} = 0.85\phi[.85f'_c(A_g - A_{st}) + f_y A_{st}]$			X		
A2	$\phi P_{n(max)} = 0.80\phi[.85f'_c(A_g - A_{dy}) + f_y A_{st}]$				X	
A3	$\phi P_{n(max)} = 0.85\phi P_o$	X				
A4	$\phi P_{n(max)} = 0.80\phi P_o$		X			
A5	DLT 10.3(f)	X	X	X	X	
A6	Logical Error					X

Comments: 1) DLT 10.3(e) develops $\phi P_{n(max)}$ from Section 10.3.5.

2) It was assumed that the only lateral tie reinforcement possible is spiral or tie.

Datum 10.3(f)	Source	Label	Number
Design axial load strength used.	X	ϕP_n	
Maximum allowable design axial load strength.	DLT 10.3(e)	$\phi P_{n(max)}$	

DLT 10.3(f) Axial Load Strength Check		1	2
C1	$\phi P_n \leq \phi P_{n(max)}$?	Y	N
A1	Provisions = satisfied	X	
A2	Provisions ≠ satisfied		X
A3	DLT 10.3(g)	X	X

Comment: 1) DLT 10.3(f) performs the check required in Section 10.3.5.

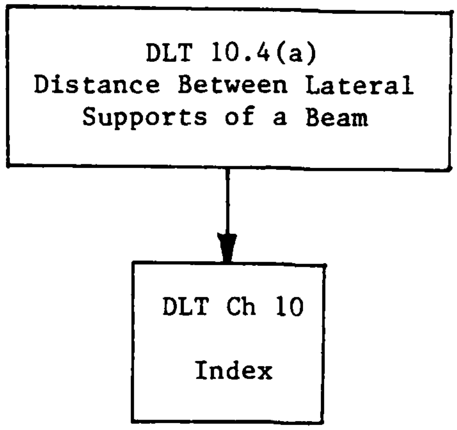
Datum 10.3(g)	Source	Label	Number
Member loading.	X		
Factored axial load at given eccentricity.	X	P_u	
Maximum allowable design axial load strength.	DLT 10.3(e)	$\phi P_{n(max)}$	
If member is designed for maximum moment which can accompany the axial load.	X		
If maximum factored moment, M_u, is magnified for slenderness effects in accordance with Section 10.10.	X		

DLT 10.3(g)	Axial Load and Moment Check	1	2	3	4	5	
C1	Member subject to compressive axial load?	Y	Y	Y	Y	N	E
C2	$P_u \leq \phi P_{n(max)}$?	Y	Y	Y	N		L
C3	Member designed for the maximum moment which can accompany the axial load?	Y	Y	N	I		S E
C4	M_u magnified for slenderness effects in accordance with Section 10.10?	Y	N	I	I		
A1	Provisions = satisfied	X					
A2	Provisions ≠ satisfied		X	X	X		
A3	No provision					X	
A4	DLT Ch 10	X	X	X	X	X	
A5	Logical Error						X

Comments: 1) DLT 10.3(g) covers Section 10.3.6.

2) M_u in this section is apparently M_2 defined in the notation of Ch 10.

Section 10.4 Map



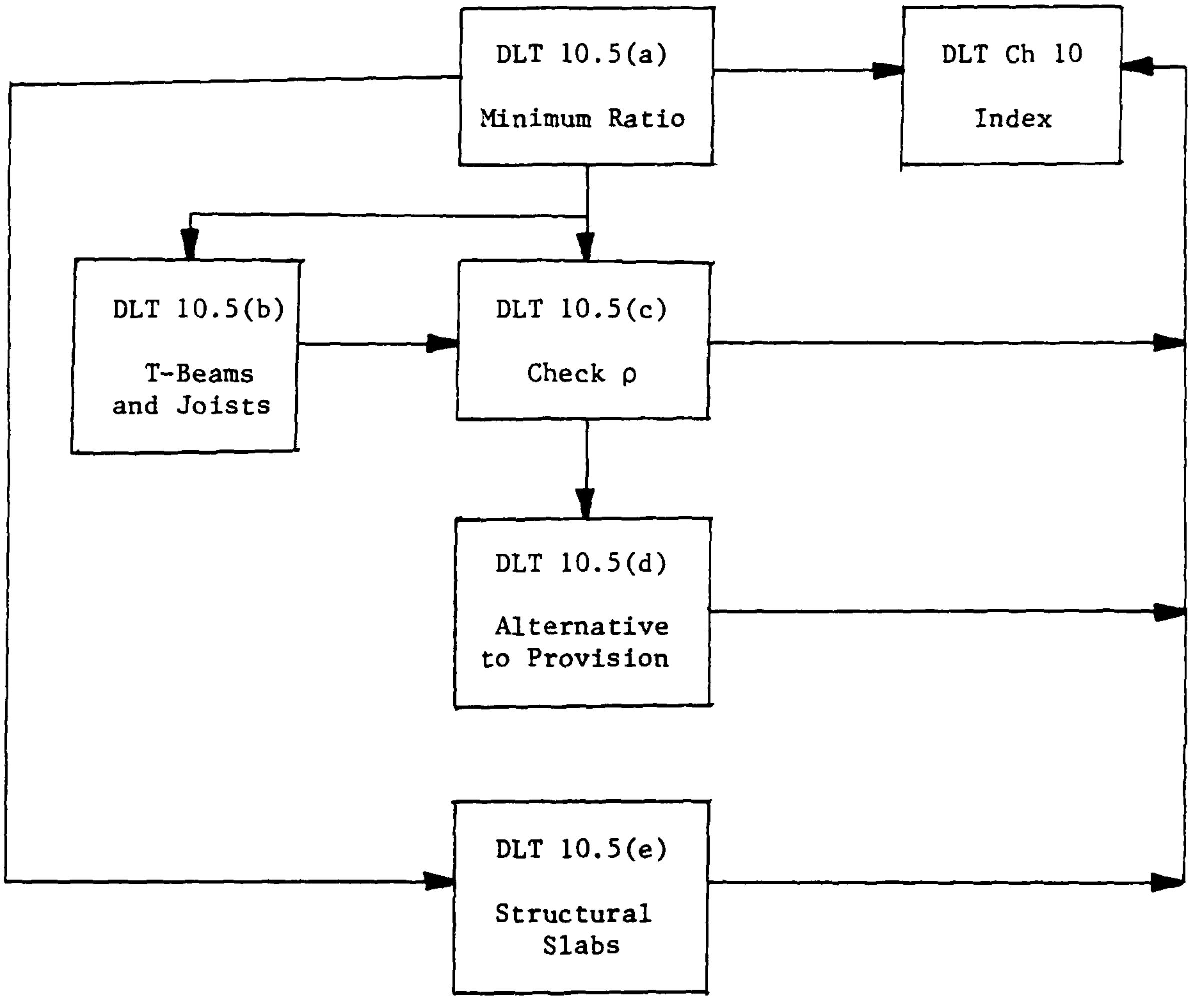
Section 10.4 Distance Between Lateral Supports of Flexural Members

Datum 10.4(a)	Source	Label	Number
Spacing of lateral supports for a beam.	X		
Least width, b, of the compression face or flange.	X		
If spacing of lateral supports was determined considering effect of lateral eccentricity of load.	X		

DLT 10.4(a)	Distance Between Lateral Supports of a Beam	1	2	3
C1	Spacing of lateral supports for a beam $\leq$ 50 times the least width, b, of the compression flange or face?	Y	Y	N
C2	Spacing of lateral supports determined considering effects of lateral eccentricity of load?	Y	N	I
A1	Provisions = satisfied	X		
A2	Provisions $\neq$ satisfied		X	X
A3	DLT Ch 10	X	X	X

Comment: 1) DLT 10.4(a) covers Section 10.4

Section 10.5 Map



Section 10.5 Minimum Reinforcement of Flexural Members

Datum 10.5(a)	Source	Label	Number
If positive reinforcement is required by analysis.	X		
Member type.	X		

	DLT 10.5(a) Minimum Reinforcement Ratio	1	2	3	4	
C1	Positive reinforcement required by analysis?	Y	Y	Y	N	E
C2	Member type = T-beam or joist with web in tension?	Y	N	N		L
						S
C3	Member type = structural slab of uniform thickness?	N	Y	N		E
A1	$\rho_{min} = 200/f_y$	X		X		
A2	DLT 10.5(b)	X				
A3	DLT 10.5(c)			X		
A4	DLT 10.5(e)		X			
A5	No provision, DLT Ch 10				X	
A6	Logical Error					X

Comment: 1) DLT 10.5(a) partially covers Section 10.5.1.

Datum 10.5(b)	Source	Label	Number
If ρ is computed using width of web.	X		

DLT 10.5(b) T-Beams and Joists		1	2
C1	ρ computed using width of web?	Y	N
A1	Provisions = satisfied	X	
A2	Provisions $\neq$ satisfied		X
A3	DLT 10.5(c)	X	X

Comment: 1) DLT 10.5(b) partially covers Section 10.5.1.

Datum 10.5(c)	Source	Label	Number
Ratio of non-prestressed tension reinforcement provided.	X	ρ	
Minimum ratio of non-prestressed tension reinforcement.	DLT 10.5(a)	ρ_{min}	

DLT 10.5(c) Check ρ		1	2
C1	ρ provided $\geq \rho_{min}$?	Y	N
A1	Provision = satisfied	X	
A2	Provision $\neq$ satisfied		X
A3	DLT Chapter 10	X	
A4	DLT 10.5(d)		X

Comment:

1) DLT 10.5(c) partially covers Section 10.5.1.

Datum 10.5(d)	Source	Label	Number
Area of reinforcement at every positive or negative section.	X		
Area of reinforcement at every positive or negative section required by analysis.	X		

DLT 10.5(d)	Alternative to Minimum Reinforcement Ratio	1	2
C1	Area of reinforcement at every section, positive or negative, $\geq$ 1-1/3 times the area required by analysis?	Y	N
A1	Provisions = satisfied	X	
A2	Provisions $\neq$ satisfied		X
A3	DLT Ch 10	X	X

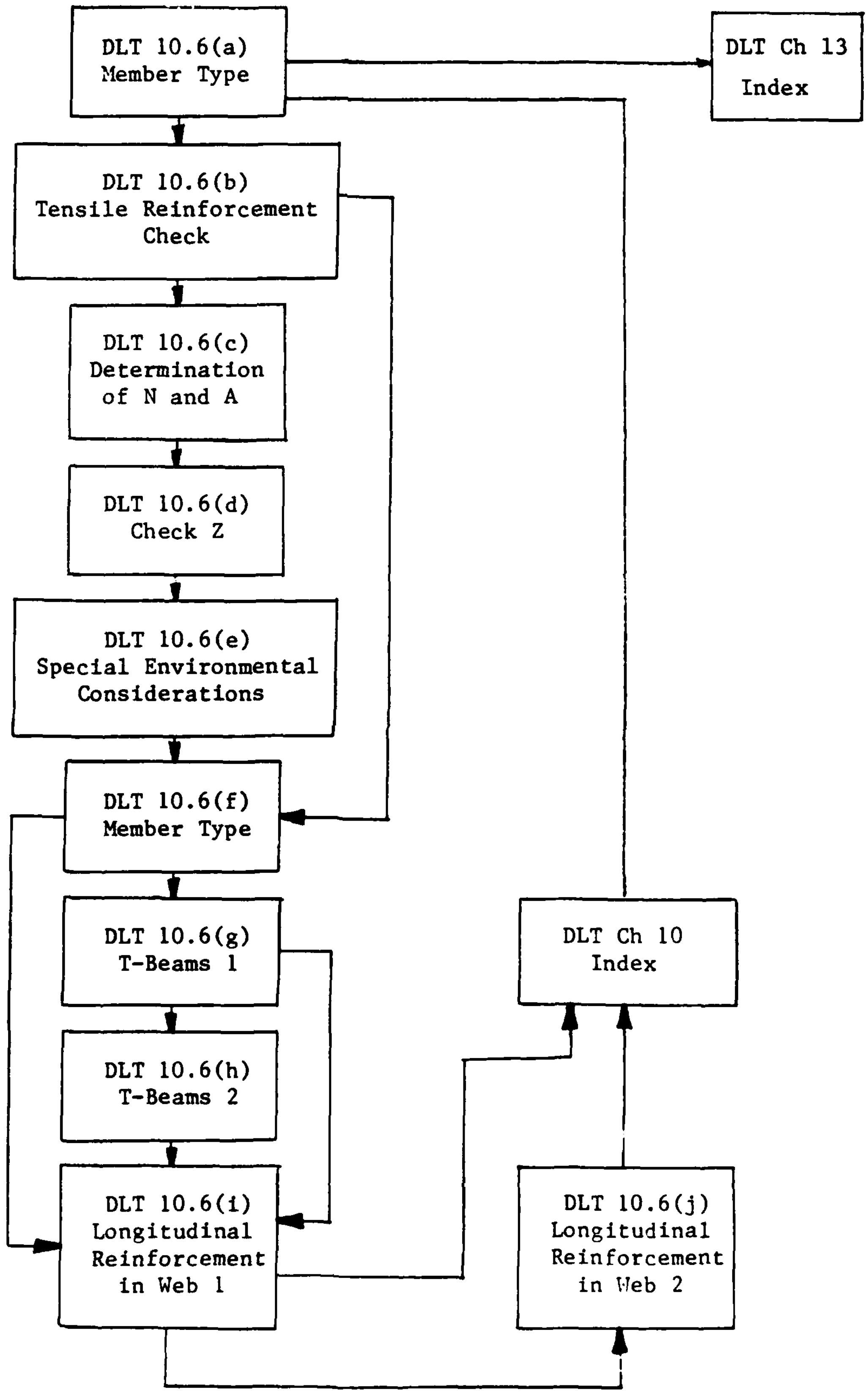
Comment: 1) DLT 10.5(d) covers Section 10.5.2.

Datum 10.5(e)	Source	Label	Number
If reinforcement area and specimen is as required by Section 7.12?	X		

DLT 10.5(e)	Structural Slabs	1	2
C1	Reinforcement area and spacing as required by Section 7.12?	Y	N
A1	Provisions = satisfied	X	
A2	Provisions ≠ satisfied		X
A3	DLT Ch 10	X	X

Comment: 1) DLT 10.5(e) covers Section 10.5.3.

Section 10.6 Map



Section 10.6 Distribution of Flexural Reinforcement in Beams and One-Way Slabs

Datum 10.6(a)	Source	Label	Number
Member type.	X		

DLT 10.6(a) Member Type		1	2	3	
C1	Member type = beam or one-way slab?	Y	N	N	ELSE
C2	Member type = two-way slab?	N	Y	N	
A1	DLT 10.6(b)	X			
A2	DLT Ch 13		X		
A3	DLT Ch 10			X	
A4	Logical Error				X

Comment: 1) DLT 10.6(a) covers Section 10.6.1 and 10.6.2.

Datum 10.6(b)	Source	Label	Number
Specified yield strength of non-prestressed reinforcement, psi.	X	f_y	
Calculated stress in reinforcement at service loads, ksi.	X	f_s	

DLT 10.6(b)	Tensile Reinforcement Check	1	2	3	4	
C1	f_y > 40000 psi?	Y	Y	Y	N	E
C2	f_s = moment divided by the product of steel area and internal moment arm?	Y	N	N		L S
C3	$f_s = 0.60\ f_y$?	N	Y	N		E
A1	Provisions = satisfied	X	X			
A2	Provisions ≠ satisfied			X		
A3	DLT 10.6(c)	X	X	X		
A4	DLT 10.6(f)				X	
A5	Logical Error					X

Comments: 1) DLT 10.6(b) partially covers Sections 10.6.3 and 10.6.4.

2) In Section 10.0 of the Code, f_s is defined in terms of ksi and f_y in terms of psi. For C3 above, f_s is in psi.

Datum 10.6(c)	Source	Label	Number
Effective tension area, sq in., of concrete surrounding the flexural tension reinforcement and having the same centroid as the reinforcement.	X	$\overline{A}$	
Total area of reinforcement, sq in.	X		
Number of bars or wires.	X	$\overline{N}$	
Area of largest bar or wire.	X		

DLT 10.6(c) Determination of N and A		1	2
C1	Flexural reinforcement, all of same bar or wire sizes?	Y	N
A1	$N = \overline{N}$	X	
A2	N = total area of reinforcement divided by the area of the largest bar or wire.		X
A3	$A = \overline{A}/N$	X	X
A4	DLT 10.6(d)	X	X

Comment:

1) DLT 10.6(c) covers the determination of A implicit in the Notation for Chapter 10.

Datum 10.6(d)	Source	Label	Number
Calculated stress in reinforcement at service load, ksi.	X	f_s	
Thickness of concrete cover measured from extreme tension fiber to center of bar or wire located closest thereto, in.	X	d_c	
Effective tension area of concrete surrounding the flexural tension reinforcement and having the same centroid as that reinforcement divided by the number of bars or wires, sq in.	DLT 10.6(c)	A	

DLT 10.6(d) Check Z		1	2	3	4	
C1	Interior exposure?	Y	Y	N	N	E
C2	$Z = f_s(d_cA)^{1/3} < 175$ ksi?	Y	N	Y	I	L S
C3	$Z = f_s(d_cA)^{1/3} < 145$ ksi?	I	N	Y	N	E
A1	Provisions = satisfied	X		X		
A2	Provisions ≠ satisfied		X		X	
A3	DLT 10.6(e)	X	X	X	X	
A4	Logical Error					X

Comment: 1) DLT 10.6(d) partially covers Section 10.6.4.

Datum 10.6(e)	Source	Label	Number
If the structure is subject to very aggressive exposure or designed to be watertight.	X		
If special investigations are done or special precautions taken.	X		

DLT 10.6(e)	Special Environment Considerations	1	2	3
C1	Structure subject to very aggressive exposure or designed to be watertight?	Y	Y	N
C2	Special investigations done or special precautions taken?	Y	N	I
A1	Provisions = satisfied	X		X
A2	Provisions ≠ satisfied		X	
A3	DLT 10.6(f)	X	X	X

Comment: 1) DLT 10.6(e) covers Section 10.6.5.

Datum 10.6(f)	Source	Label	Number
Member type.	X		

DLT 10.6(f) Member Type		1	2
C1	Member type = T-beam?	Y	N
A1	DLT 10.6(g)	X	
A2	DLT 10.6(i)		X

Datum 10.6(g)	Source	Label	Number
If T-beam flanges are in tension.	X		
Distribution of flexural tension reinforcement.	X		

DLT 10.6(g)	T-Beams 1	1	2	3
C1	Flanges of T-beam in tension?	Y	Y	N
C2	Part of the flexural tension reinforcement distributed over a width = min[Effective flange width per Section 8.10 1/10 span] ?	Y	N	I
A1	Provisions = satisfied	X		
A2	Provisions ≠ not satisfied		X	
A3	DLT 10.6(h)	X	X	
A4	DLT 10.6(i)			X

Comment: 1) DLT 10.6(g) partially covers Section 10.6.6.

Datum 10.6(h)	Source	Label	Number
Effective flange width per Section 8.10	Section 8.10		
Span length of flexural member.	X	ℓ	
If some longitudinal reinforcement is provided in the outer portions of the flange.	X		

DLT 10.6(h) T-Beams 2		1	2	3
C1	Effective width per Section 8.10 > $\ell/10$?	Y	Y	N
C2	Some longitudinal reinforcement provided in the outer portions of the flange?	Y	N	I
A1	Provisions = satisfied	X		X
A2	Provisions ≠ satisfied		X	
A3	DLT 10.6(i)	X	X	X

Comment: 1) DLT 10.6(h) partially covers Section 10.6.6.

Datum 10.6(i)	Source	Label	Number
Depth of web.	X		
Width of web.	X		
Location and spacing of longitudinal reinforcement in the cross section.	X		
Total area of nonprestressed tension reinforcement, sq in.	X	A_s	

DLT 10.6(i)	Longitudinal Reinforcement in Web - 1	1	2	3
C1	Depth of web > 3 ft?	Y	Y	N
C2	Longitudinal reinforcement having a total area $> 0.10 A_s$ placed near the side of the web with spacing $\le$ min[web width, 12 in.] ?	Y	N	I
A1	Provisions = satisfied	X		
A2	Provisions ≠ satisfied		X	
A3	DLT 10.6(j)	X		
A4	DLT Ch 10		X	X

Comments: 1) DLT 10.6(i) partially covers Section 10.6.7.

2) The direction of spacing in C2 is not given in the Code.

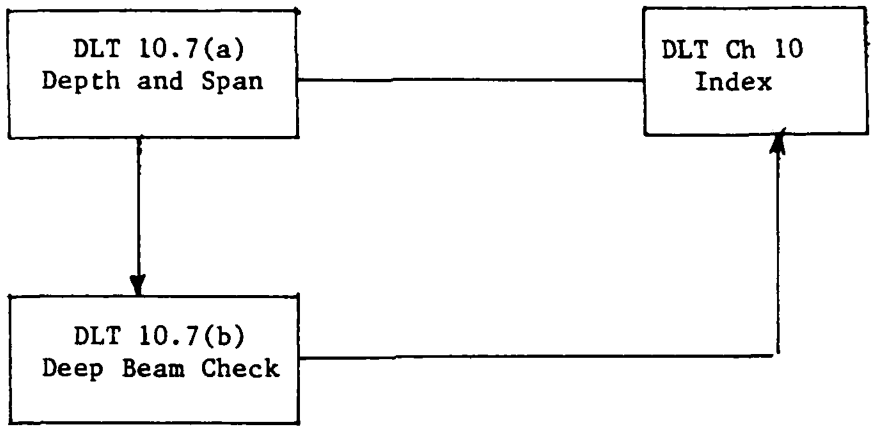
3) There is no criterion for "near the side of the web".

Datum 10.6(j)	Source	Label	Number
If longitudinal reinforcement which is placed near the sides of the web is included in the strength analysis.	X		
If strain compatibility analysis determines stresses in individual bars or wires.	X		

DLT 10.6(j) Longitudinal Reinforcement in Web - 2		1	2	3
C1	Longitudinal reinforcement placed near the web included in strength analysis?	Y	Y	N
C2	Stresses in individual bars or wires determined by strain compatibility analysis?	Y	N	I
A1	Provisions = satisfied	X		
A2	Provisions ≠ satisfied		X	
A3	DLT Ch 10	X	X	X

Comment: 1) DLT 10.6(j) partially covers Section 10.6.7.

Section 10.7 Map



Section 10.7 Deep Flexural Members

Datum 10.7(a)	Source	Label	Number
Overall Depth-span ratio	X		
Type of span	X		

DLT 10.7(a) Depth and Span		1	2	3	4	5	
C1	Overall depth-span ratio > 2/5?	Y	Y	Y	N	I	E
C2	Overall depth-span ratio > 4/5?	Y	I	Y	N	N	L
C3	Continuous span?	N	Y	N	Y	N	S
C4	Simple span?	Y	N	N	N	I	E
A1	DLT 10.7(b)	X	X				
A2	No Provision - DLT Ch 10			X	X	X	
A3	Logical Error						X

Comment: 1) DLT 10.7(a) partially covers Section 10.7.1

Datum 10.7(b)	Source	Label	Number
If designed at a flexural member taking into account nonlinear distribution of strain and lateral buckling into account.	X		
If provisions of Section 11.8 are satisfied.	X		
If provisions of Section 10.5 are satisfied.	X		
Area of vertical reinforcement in side faces.	X		
Area of horizontal reinforcement in side faces.	X		
Width of compression face of member, in.	X	b	

DLT 10.7(b) Deep Beam Check		1	2	3	4	5
C1	Designed as a deep flexural member taking nonlinear distribution of strain and lateral buckling into account?	Y	Y	Y	Y	N
C2	Provisions of Section 11.8 = satisfied?	Y	Y	Y	N	I
C3	Provisions of Section 10.5 = satisfied?	Y	Y	N	I	I
C4	Area of vertical reinforcement in side faces > 0.0015(b) and area of horizontal reinforcement in side faces > 0.0025(b)?	Y	N	I	I	I
A1	Provisions = satisfied	X				
A2	Provisions ≠ satisfied		X	X	X	X
A3	DLT Ch 10	X	X	X	X	X

(Continued)

DLT 10.7(b) (continued)

Comments: 1) DLT 10.7(b) covers Sections 10.7.1.

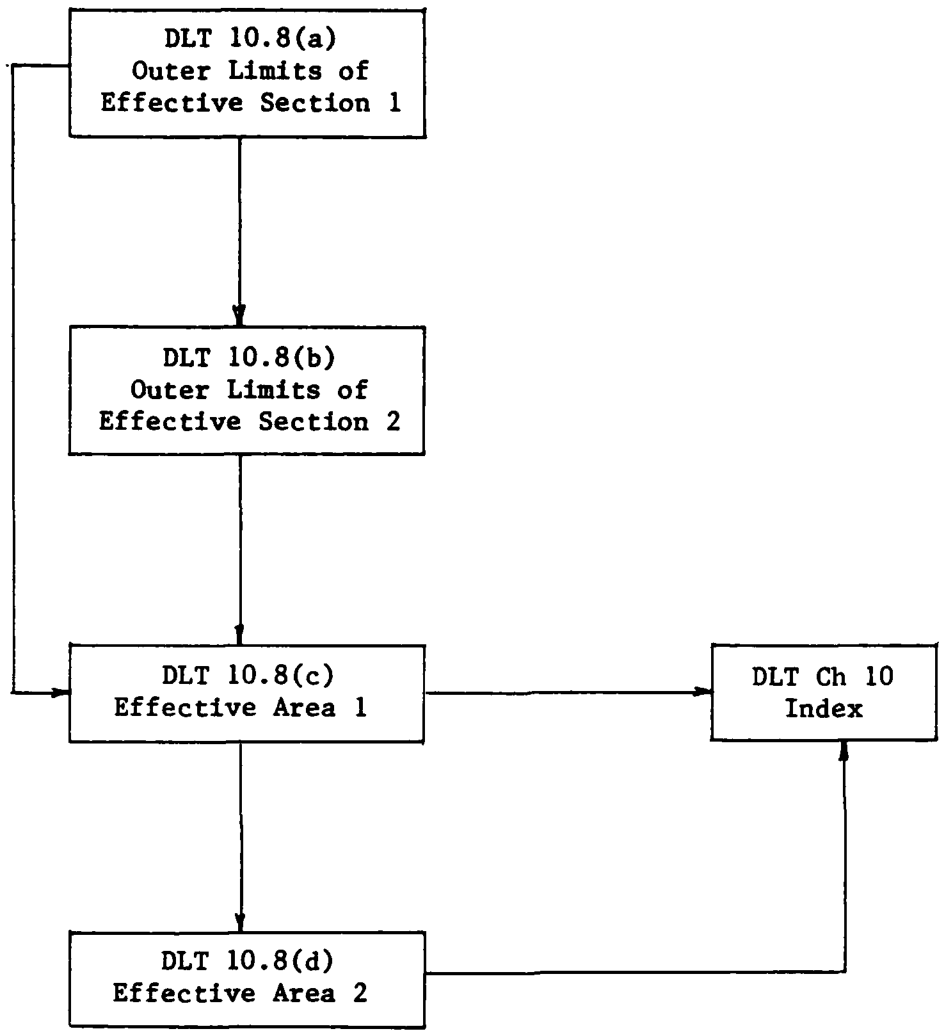
2) An inconsistency exists in the Code in Sections 10.7 and 11.8 between the definitions of a deep beam. Section 11.8 only applies to ratios < 5 while Section 10.7 defines a continuous beam with a span-depth ratio < 2.5 or simple spans with span-depth ratio < 1.25 as a deep beam.

3) The provisions of Section 10.6.7 seem to be a lower bound applying to deep beams. Perhaps Section 10.6.7 could be placed in Section 10.7.

4) C4 of DLT 10.7(b) was formulated assuming that the requirements of interest pertain only to area of reinforcement and not to spacing. Sections 11.8.8 and 11.8.9 of the Code do provide requirements for vertical and horizontal spacing which could be included in this DLT, however.

5) The phrase in paragraph 10.7.4 "... shall be greater of the requirements of Sections 11.8.8 and 11.8.9 or Sections 14.2.10 and 14.2.11.", is confusing because the required area is basically the same on a unit basis. Sections 11.8.8 and 11.8.9 give area within the spacing distances s and s_2 while Sections 14.2.10 and 14.2.11 give a total area which is the same per unit of length.

Section 10.8 Map



Section 10.8 Design Dimensions for Compression Members

Datum 10.8(a)	Source	Label	Number
Minimum concrete cover.	DLT 7.7(n)	MCC	
Member type.	X		
Outer limits of effective cross section used.	X		

DLT 10.8(a) Outer Limits of Effective Section 1		1	2	3	
C1	Member type = isolated compression member with two or more interlocking spirals?	Y	Y	N	ELSE
C2	Outer limits of effective cross section = distance outside extreme limits of the spirals equal to MCC?	Y	N		
A1	Provisions = satisfied	X			
A2	Provisions ≠ satisfied		X		
A3	DLT 10.8(b)			X	
A4	DLT 10.8(c)	X	X		
A5	Logical Error				X

Comment: 1) DLT 10.8(a) covers Section 10.8.1.

Datum 10.8(b)	Source	Label	Number
Member type.	X		
Outer limits of cross section used.	X		
Spiral dimensions.	X		

	DLT 10.8(b) Outer Limits of Effective Section 2	1	2	3	4	
C1	Member type = spirally reinforced compression member built monolithically with a concrete wall or pier?	Y	Y	Y	N	E
						L
C2	Outer limits of effective cross section = circle with radius $\geq$ spiral radius + $1\frac{1}{2}$ in.?	Y	N	N		S
						E
C3	Outer limits of effective cross section = square or rectangle with sides $\geq 1\frac{1}{2}$ in. outside the spiral?	N	Y	N		
A1	Provisions = satisfied	X	X			
A2	Provisions $\neq$ satisfied			X		
A3	DLT 10.8(c)	X	X	X	X	
A4	Logical Error					X

Comment:

1) DLT 10.8(b) covers Section 10.8.2.

Datum 10.8(c)	Source	Label	Number
If cross section is larger than required based on considerations of loading.	X		
If reduced effective area is used to determine minimum reinforcement + design strength.	X		

DLT 10.8(c)	Effective Area 1	1	2	3	
C1	Cross section larger than required based on considerations of loading?	Y	Y	N	ELSE
C2	Reduced effective area used to determine minimum reinforcement and design strength?	Y	N		
A1	DLT 10.8(d)	X			
A2	DLT Ch 10		X	X	
A3	Logical Error				X

Comment: 1) DLT 10.8(c) partially covers Sections 10.8.3 and 10.8.4.

Datum 10.8(d)	Source	Label	Number
Shape of section.	X		
If shape is assumed to be circular with a diameter equal to the least lateral dimension of the actual non-circular section.	X		
Reduced effective area used.	X	$\overline{A}_g$	
Total area of section.	X		

DLT 10.8(d) Effective Area 2		1	2	3	4	
C1	Shape of section = circular?	Y	Y	N	N	E
C2	Shape assumed to be circular with diameter = least lateral dimension of the actual non-circular section?			I	I	L S
C3	$\overline{A}_g = \frac{1}{2}$ total area?	Y	N	Y	N	E
A1	Provisions = satisfied	X		X		
A2	Provisions ≠ satisfied		X		X	
A3	DLT Chapter 10	X	X	X	X	
A4	Logical Error					X

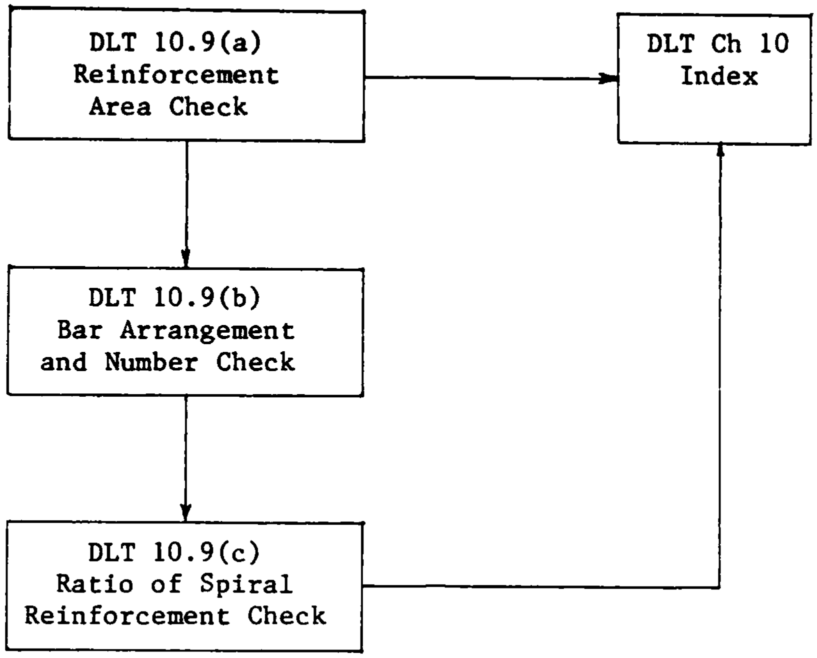
Comments:

1) DLT 10.8(d) partially covers Sections 10.8.3 and 10.8.4.

2) The Code does not specifically address circular sections larger than required. They are considered in Decision Rules 1 and 2 above.

3) The requirement in Section 10.8.3, "Gross area considered, required percentage of reinforcement and design strength shall be based on that circular section" could conflict with the requirement in Section 10.8.4 "...a reduced effective area not less than 1/2 the total area may be used....". It is assumed here that the requirement of C3 above takes precedence over the requirement from Section 10.8.3.

Section 10.9 Map



Section 10.9 Limits for Reinforcement of Compression Members

Datum 10.9(a)	Source	Label	Number
Member type.	X		
Gross area of section, sq in.	X	A_g	
Total area of longitudinal reinforcement, sq in.	X	A_{st}	

DLT 10.9(a)	Reinforcement Area Check	1	2	3
C1	Noncomposite compression member?	Y	Y	N
C2	$0.01\ A_g \leq A_{st} \leq 0.08\ A_g$?	Y	N	I
A1	Provisions = satisfied	X		
A2	Provisions ≠ satisfied		X	
A3	No Provisions, DLT Ch 10			X
A1	DLT 10.9(b)	X	X	

Comment: 1) DLT 10.9(a) covers Section 10.9.1.

Datum 10.9(b)	Source	Label	Number
Arrangement of longitudinal bars.	X		
Number of Longitudinal bars.	X		

	DLT 10.9(b) Bar Arrangement and Number Check	1	2	3	4	
C1	Longitudinal bar arrangement = circular?	Y	Y	N	N	E
C2	Longitudinal bar arrangement = rectangular?	N	N	Y	Y	L
C3	Number of bars ≥ 4?	Y	I	Y	N	S
C4	Number of bars ≥ 6?	Y	N	I	N	E
A1	Provisions = satisfied	X		X		
A2	Provisions ≠ satisfied		X		X	
A3	DLT 10.9(c)	X	X	X	X	
A4	Logical Error					X

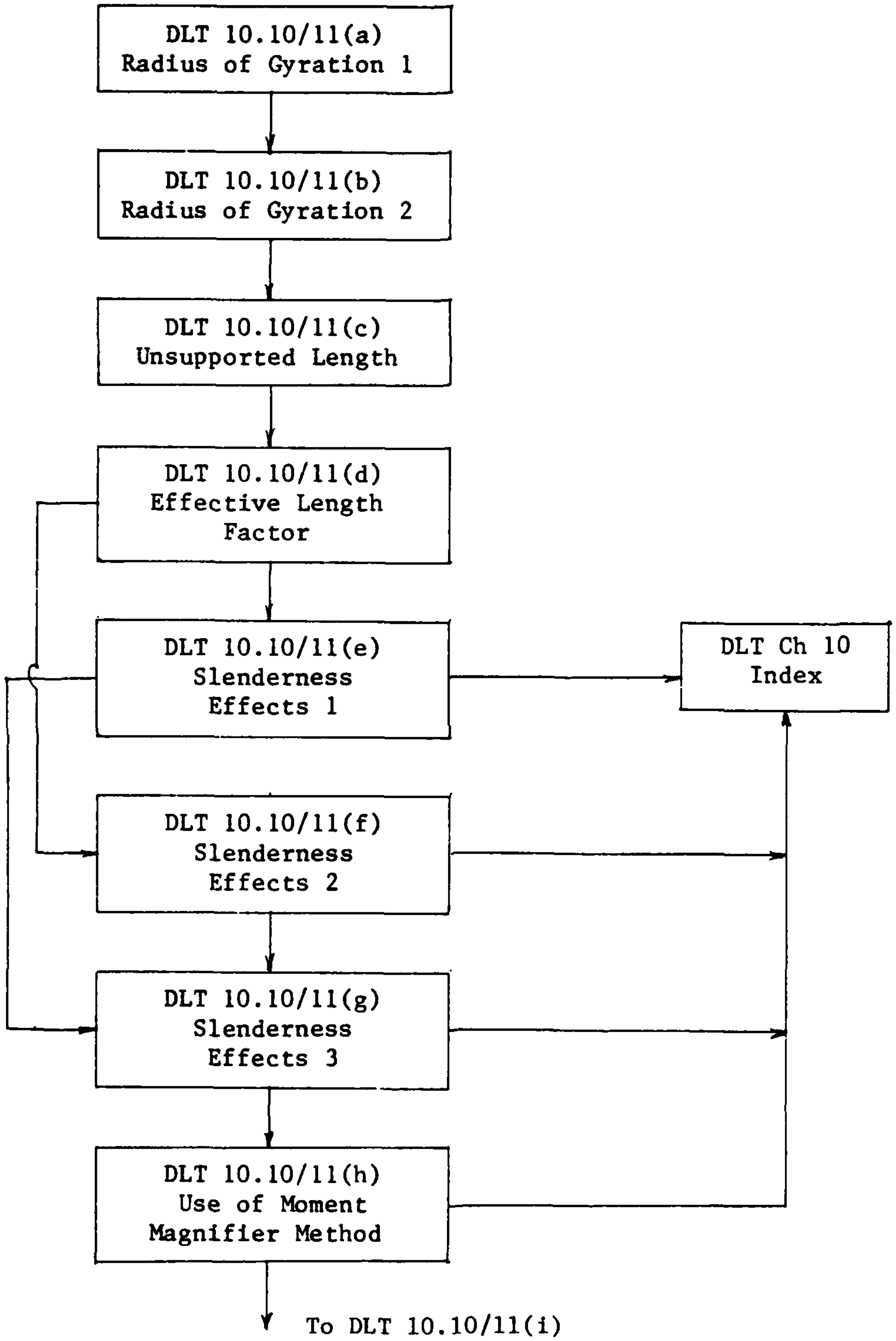
Comment: 1) DLT 10.9(b) covers Section 10.9.2.

Datum 10.9(c)	Source	Label	Number
Ratio of volume of spiral reinforcement to total volume of core of a spirally reinforced member.	X	ρ_s	
Specified compressive strength of concrete, psi.	X	f'_c	
Gross area of section, sq in.	X	A_g	
Specified yield strength of non-prestressed reinforcement, psi.	X	f_y	
Area of core of spirally reinforced member measured to outside diameter of spiral, sq in.	X	A_c	

DLT 10.9(c)	Ratio of Spiral Reinforcement Check	1	2	3
C1	$\rho_s \geq 0.45 \left(\frac{A_g}{A_c} - 1\right) \frac{f'_c}{f_y}$?	Y	Y	N
C2	$f_y \leq 60000$ psi?	Y	N	I
A1	Provisions = satisfied	X		
A2	Provisions ≠ satisfied		X	X
A3	DLT Ch 10	X	X	X

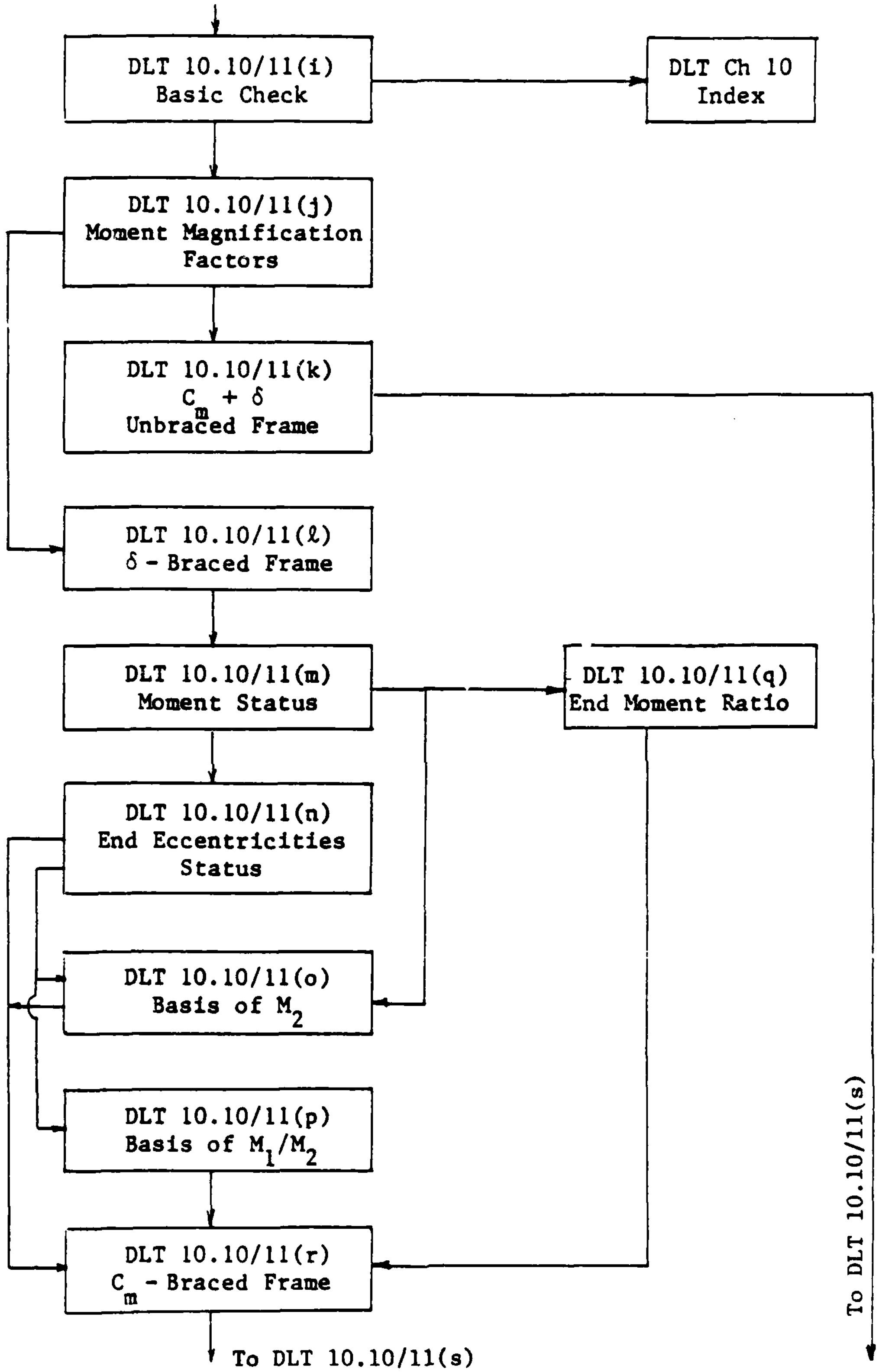
Comment: 1) DLT 10.9(c) covers Section 10.9.3.

Section 10.10/11 Map



(Continued)

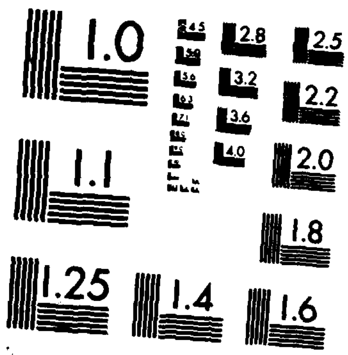
(Sheet 1 of 3)



(Continued)

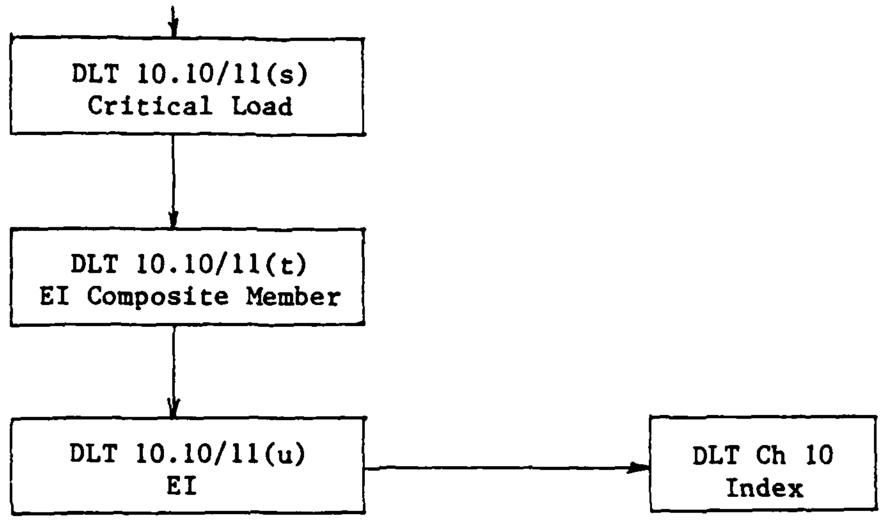
(Sheet 2 of 3)

AD-A173 663 COMPUTER-AIDED STRUCTURAL ENGINEERING (CASE) PROJECT· 4/6
DECISION LOGIC TABL (U) ATKINSON-NOLAND & ASSOCIATES
INC BOULDER CO J L NOLAND JUL 86 ATC-TR-86-5-VOL-1
UNCLASSIFIED DACW39-82-M-3741 F/G 9/2 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Section 10.10/11 Map (Concluded)



(Sheet 3 of 3)

Section 10.10/11 Slenderness Effects in Compression Members/Approximate Evaluation of Slenderness Effects

Datum 10.10/11(a)	Source	Label	Number
Shape of cross section.	X		
Dimension in the direction in which stability is considered.	X		
If radius of gyration is computed from cross section.	X		
Radius of gyration used.	X	r	

	DLT 10.10/11(a) Radius of Gyration 1	1	2	3	4	5	6	7	
C1	Cross-section slope = circular?	N	Y	Y	N	I	N	N	
C2	Cross-section shape = rectangular?	I	N	N	Y	N	I	I	E
C3	r = 0.30 times the overall dimension in the direction in which stability is considered?	N	N	N	Y	Y	N	N	L S
C4	r = diameter/4?	N	Y	N	N	N	Y	N	E
C5	r computed for the gross concrete section?	Y	N	I	N	N	N	N	
A1	Provisions = satisfied	X	X	X	X			X	
A2	Provisions ≠ satisfied					X	X		
A3	DLT 10.10/11(b)	X	X	X	X	X	X	X	
A4	Logical Error								X

Comments: 1) DLT 10.10/11(a) covers Section 10.11.3.

2) The provisions of Section 10.11.3 are optional, hence in this DLT, r computed from the gross section is considered acceptable for circular and rectangular cross sections and r computed by none of the above is also acceptable.

Datum 10.10/11(b)	Source	Label	Number
Modulus of elasticity of concrete, psi.	X	E_c	
Moment of inertia of gross concrete section about centroidal axis, neglecting reinforcement.	X	I_g	
Modulus of elasticity of reinforcement, psi.	X	E_s	
Moment of inertia of structural steel shape, pipe or tubing about centroidal axis of composite member cross section.	X	I_t	
Gross area of section, sq in.	X	A_g	
Area of structural steel shape, pipe, or tubing in composite section, sq in.	X	A_t	

DLT 10.10/11(b)	Radius of Gyration 2	1	2	3
C1	Composite compression member?	Y	Y	N
C2	$r \leq \left[\frac{(E_c I_g/5) + E_s I_t}{(E_c A_g/5) + E_s A_t}\right]^{\frac{1}{2}}$?	Y	N	I
A1	Provisions = satisfied	X		
A2	Provisions ≠ satisfied		X	
A3	DLT 10.10/11(c)	X	X	X

Comments: 1) DLT 10.10/11(b) covers part of Section 10.14.5

2) Note that r for a composite member may be determined by one or none of the methods in DLT 10.10/11(a). The value in C2 above is an upper limit.

Datum 10.10/11(c)	Source	Label	Number
Unsupported length of compression member.	X	ℓ_u	
If column capitals or haunches are present.	X		
If ℓ_u is measured to the lowest extremity of capital or haunch in the plane considered.	X		
Clear distance between floor slabs, beams, or other members capable of providing lateral support.	X		

DLT 10.10/11(c) Unsupported Length		1	2	3	4	5	
C1	Column capitals or haunches present?	Y	Y	Y	N	N	E
C2	ℓ_u = clear distance between floor slabs, beams, or other members capable of providing lateral support?	Y	Y	N	Y	N	L S
C3	ℓ_u measured to lowest extremity of capital or haunch in the plane considered?	Y	N	I			E
A1	Provisions = satisfied	X			X		
A2	Provisions ≠ satisfied		X	X		X	
A3	DLT 10.10/11(d)	X	X	X	X	X	
A4	Logical Error						X

Comment: 1) DLT 10.10/11(c) covers Section 10.11.1.

Datum 10.10/11(d)	Source	Label	Number
If the compression member is braced against sidesway.	X		
Effective length factor used.	X	k	
If k is determined with due consideration of cracking and reinforcement on relative stiffness.	X		
Value of k determined by analysis.	X		

DLT 10.10/11(d)	Effective Length Factor	1	2	3	4	
C1	Compression member braced against sidesway?	Y	Y	N	N	E
C2	$k = \min[1.0$, value determined by analysis$]$?	Y	N	Y	N	L
C3	$k > 1$ and determined with due consideration of cracking and reinforcement on relative stiffness?	N	Y	N	Y	S E
A1	Provisions = satisfied	X			X	
A2	Provisions ≠ satisfied		X	X		
A3	DLT 10.10/11(e)	X	X			
A4	DLT 10.10/11(f)			X	X	
A5	Logical Error					X

Comment: 1) DLT 10.10/11(d) covers Section 10.11.2.

Datum 10.10/11(e)	Source	Label	Number
Effective length factor.	X	k	
Unsupported length of compression member.	X	ℓ_u	
Radius of gyration.	X	r	

DLT 10.10/11(e) Slenderness Effects 1		1	2	3
C1	$k\ell_u/r < (34 - 12M_1/M_2)$?	Y	I	N
C2	Slenderness effects neglected?	Y	N	Y
A1	Provisions = satisfied, DLT Ch 10	X		
A2	Provisions ≠ satisfied, DLT Ch 10			X
A3	DLT 10.10/11(g)		X	

Comment: 1) DLT 10.10/11(e) covers Section 10.11.4.1.

Datum 10.10/11(f)	Source	Label	Number
Effective length factor.	X	k	
Unsupported length of compression member.	X	ℓ_u	
Radius of gyration.	X	r	
If slenderness is neglected.			

	DLT 10.10/11(f) Slenderness Effects 2	1	2	3
C1	$k\ell_u/r < 22$?	Y	I	N
C2	Slenderness effects neglected?	Y	N	Y
A1	Provisions = satisfied, DLT Ch 10	X		
A2	Provisions ≠ satisfied, DLT Ch 10			X
A3	DLT 10.10/11(g)		X	

Comment: 1) DLT 10.10/11(f) covers Section 10.11.4.2.

Datum 10.10/11(g)	Source	Label	Number
Effective length factor.	X	k	
Unsupported length of compression member.	X	ℓ_n	
Radius of gyration.	X	r	
Basis of analysis.	X		

	DLT 10.10/11(g) Slenderness Effects 3	1	2	3	4	5	6	
C1	$k\ell_u/r > 100$?	Y	Y	Y	N	N	N	
C2	Design based on forces and moments determined from analysis of the structure?	Y	Y	N	Y	Y	N	E L
C3	Analysis considers influence of axial loads and variable moment of inertia on member stiffness and fixed-end moments, effect of deflections on moments and forces, and the effects of duration of load.	Y	N		Y	N		S E
A1	Provisions = satisfied, DLT Ch 10	X			X			
A2	Provisions ≠ satisfied, DLT Ch 10		X	X		X		
A3	DLT 10.10/11(h)						X	
A4	Logical Error							X

Comments: 1) DLT 10.10/11(g) covers Sections 10.10.1 and 10.11.4.3.

2) It was assumed that if a rigorous consideration of slenderness effects per Section 10.10.1 is not done, then the approximate methods of Section 10.11 are used.

3) As the preceding DLT's are structured, C1 above could be evaluated using values of k, ℓ_u, and r which have not satisfied requirements. This phenomenon occurs elsewhere, as well.

Datum 10.10/11(h)	Source	Label	Number
If moment magnifier method is used.	X		

DLT 10.10/11(h)	Use of Moment Magnifier Method	1	2
C1	Moment magnifier method used?	Y	N
A1	Provision = satisfied	X	
A2	No Provision, DLT Ch 10		X
A3	DLT 10.10/11(i)	X	

Datum 10.10/11(i)	Source	Label	Number
Factored axial load at a given eccentricity (from a conventional frame analysis).	X	P_u	
Axial load used in design.	X		
If compression member is designed for a magnified factored moment defined by δM_2.	X		

DLT 10.10/11(i) Basic Check		1	2	3
C1	Compression member designed for a magnified factored moment defined as δM_2 about each axis?	Y	Y	N
C2	Design axial load for compression member = P_u?	Y	N	I
A1	Provisions = satisfied	X		
A2	Provisions ≠ satisfied		X	X
A3	DLT 10.10/11(j)	X	X	
A4	DLT Ch 10			X

Comments:

1) DLT 10.10/11(i) partially covers Section 10.11.5.1.

2) The definition of M_c in "Notation" does not agree with the definition in Section 10.11.5.1.

3) This DLT covers Section 10.11.7 and that portion of Section 10.11.5.4 which requires M_2 to be determined for each axis.

4) Definitions: M_2 = value of larger factored end moment on compression member calculated by conventional elastic frame analysis, always positive. δ = moment magnification factor.

Datum 10.10/11(j)	Source	Label	Number
If frame is braced against sidesway.	X		
Value of factor, used in design, relating actual moment diagram to an equivalent uniform moment diagram.	X	C_m	
Factored axial load at given eccentricity.	X	P_u	
Critical load.	X	P_c	

DLT 10.10/11(j)	Moment Magnification Factors	1	2
C1	Frame not braced against sidesway?	Y	N
A1	$\delta_1 = \max[C_m/(1 - P_u/\phi P_c), 1.0]$	X	X
A2	$\delta_2 = \max[C_m/(1 - \Sigma P_u/\phi \Sigma P_c), 1.0]$	X	
A3	DLT 10.10/11(k)	X	
A4	DLT 10.10/11(ℓ)		X

Comments: 1) DLT 10.10/11(j) develops values of δ in accordance with Sections 10.11.5.1 and 10.11.6.2.

2) That δ_1 in A1 above applies to braced frames must be inferred from the Code.

Datum 10.10/11(k)	Source	Label	Number
Moment magnification factor used.	X	δ	
Moment magnification factor for braced frame.	DLT 10.10/11 (j)	δ_1	
Moment magnification factor for unbraced frame.	DLT 10.10/11 (j)	δ_2	
If flexural members are designed for the total magnified end moments of the compression members at the joint.	X		
Value of factor, used in design, relating actual moment diagram to an equivalent uniform moment diagram.	X	C_m	

DLT 10.10/11(k) C_m and δ Unbraced Frame		1	2	3	4
C1	$\delta \geq \max[\delta_1, \delta_2]$?	Y	Y	Y	N
C2	Flexural members designed for the total magnified end moments of the compression members at the joint.	Y	Y	N	I
C3	$C_m = 1$?	Y	N	I	I
A1	Provisions = satisfied	X			
A2	Provisions ≠ satisfied		X	X	X
A3	DLT 10.10/11(s)	X	X	X	X

Comments: 1) DLT 10.10/11(k) covers Section 10.11.6.2.

2) That C_m must equal one for unbraced frames was inferred Section 10.11.5.3.

3) It was assumed here that a value used of $\delta \geq \delta_1$ or $_2$ would be acceptable.

Datum 10.10/11(ℓ)	Source	Label	Number
Moment magnification factor used.	X	δ	
Moment magnification factor for a braced frame.	DLT 10.10/11 (j)	δ_1	

DLT 10.10/11(ℓ) δ Braced Frame	1	2
C1 $\delta = \delta_1$?	Y	N
A1 Provisions = satisfied	X	
A2 Provisions $\neq$ satisfied		X
A3 DLT 10.10/11(m)	X	X

Comment:

1) DLT 10.10/11(ℓ) covers Eq. (10.7) in Section 10.11.5.1.

Datum 10.10/11(m)	Source	Label	Number
If computations show that there is essentially no moment at both ends of a compression member.	X		

DLT 10.10/11(m) Moment Status		1	2
C1	Computations show that there is essentially no moment at both ends of a compression member?	Y	N
A1	DLT 10.10/11(o) and DLT 10.10/11(q)	X	
A2	DLT 10.10/11(n)		X

Comments:

1) DLT 10.10/11(m) partially covers Section 10.11.5.4.

2) The first sentence of 10.11.5.4 uses the phrase "no moment at both ends," while in Section 10.11.5.4(b) the phrase used is "essentially no moment at both ends." It was assumed that both phrases were meant to be the same and that the phrase as written in Section 10.11.5.4(b) states the meaning of the Code more accurately.

Datum 10.10/11(n)	Source	Label	Number
Computed end eccentricities.	X		
Overall thickness of member, in.	X	h	

DLT 10.10/11(n) End Eccentricities Status		1	2
C1	Computed end eccentricities < (0.6 + 0.03h)?	Y	N
A1	DLT 10.10/11(o) and DLT 10.10/11(p)	X	
A2	DLT 10.10/11(r)		X

Comment: 1) DLT 10.10/11(n) partially covers Section 10.11.5.4.

Datum 10.10/11(o)	Source	Label	Number
If factored end moment, M_2, used is based on eccentricity $\geq$ (0.6 + 0.3h).	X		

DLT 10.10/11(o) Basis of M_2		1	2
C1	M_2 used based on eccentricity $\geq$ (0.6 + 0.03h) about each axis?	Y	N
A1	Provisions = satisfied	X	
A2	Provisions $\neq$ satisfied		X
A3	DLT 10.10/11(r)	X	X

Comments:

1) DLT 10.10/11(o) partially covers Section 10.11.5.4.

2) A "No" response to C1 in DLT 10.10/11(j) combined with a "Yes" response to C1 in DLT 10.10/11(k) leads to the possible conflict that a moment at the end of a member, not due to eccentricity, may be larger M_2 based on an eccemtricity of (0.6 + 0.03h).

Datum 10.10/11(p)	Source	Label	Number
If computed end moments are used to calculate M_1/M_2.	X		

DLT 10.10/11(p)	Basis of M_1/M_2	1	2
C1	Computed end moments used to calculate M_1/M_2?	Y	N
A1	Provisions = satisfied	X	X
A2	DLT 10.10/11(r)	X	X

Comments:

1) DLT 10.10/11(p) covers Section 10.11.5.4(a).

2) Definition: M_1 = value of smaller factored end moment on compressive member calculated by conventional elastic frame analysis, positive if member is bent in single curvature, negative if bent in double curvature.

Datum 10.10/11(q)	Source	Label	Number
Ratio of factored end moments used in design.	X	M_1/M_2	

DLT 10.10/11(q) End Moment Ratio		1	2
C1	$M_1/M_2 = 1$?	Y	N
A1	Provisions = satisfied	X	
A2	Provisions ≠ satisfied		X
A3	DLT 10.10/11(r)	X	X

Comment:

1) DLT 10.10/11(q) covers Section 10.11.5.4(b).

Datum 10.10/11(r)	Source	Label	Number
Existance of transverse loads between supports.			
Value of smaller factored end moment on compression member calculated by conventional elastic frame analysis, positive if member is bent in single curvature, negative if bent in double curvature.	X	M_1	
Value of larger factored end moment on compression member calculated by conventional elastic frame analysis, always positive.	X	M_2	
Value of factor, used in design, relating actual moment diagram to an equivalent uniform moment diagram.	X	C_m	

DLT 10.10/11(r)	C_m - Braced Frame	1	2	3	4	5
C1	Member braced against sidesway and without transverse loads between supports?	Y	N	Y	Y	N
C2	$C_m = \max\left[\left(0.6 + 0.4(\frac{M_1}{M_2})\right), 0.4\right]$?	Y	I	N	N	I
C3	$C_m = 1$?	I	Y	Y	N	N
A1	Provisions = satisfied	X	X	X		
A2	Provisions ≠ satisfied				X	X
A3	DLT 10.10/11(s)	X	X	X	X	X

Comments:

1) DLT 10.10/11(r) covers Section 10.11.5.3.

2) Provisions are considered satisfied in Decision Rule 3 because Eq. (10.11) of the Code (C2 above) is optional.

Datum 10.10/11(s)	Source	Label	Number
Flexural stiffness of a compression member.	X	EI	
Effective length factor for compression members.	X	k	
Critical load used.	X	P_c	
Unsupported length of compression member.	X	ℓ_u	

DLT 10.10/11(s) Critical Load		1	2
C1	$P_c = \pi^2 EI/(k\ell_u)^2$?	Y	N
A1	Provisions = satisfied	X	
A2	Provisions ≠ satisfied		X
A3	DLT 10.10/11(t)	X	X

Comment:

1) DLT 10.10/11(s) covers Eq (10.8) in Section 10.11.5.1.

Datum 10.10/11(t)	Source	Label	Number
Member type.	X		
Flexural stiffness used of a compression member.	X	EI	
Modulus of elasticity of concrete, psi.	X	E_c	
Modulus of elasticity of reinforcement, psi.	X	E_s	
Moment of inertia of gross concrete section about centroidal axis, neglecting reinforcement.	X	I_g	
Moment of inertia of structural steel shape, pipe or tubing about centroidal axis of composite cross section.	X	I_t	
Ratio of maximum factored dead load moment to maximum factored total load moment, always positive.	X	β_d	

DLT 10.10/11(t)	EI Composite Member	1	2	3
C1	Member type = composite compression?	Y	Y	N
C2	$EI \leq (E_c I_g/5)/(1 + \beta_d) + E_s I_t$	Y	N	I
A1	Provisions = satisfied	X		
A2	Provisions ≠ satisfied		X	
A3	DLT 10.10/11(u)	X	X	X

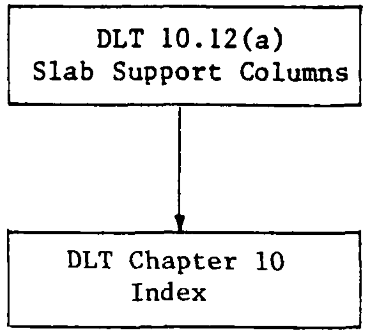
Comment: 1) DLT 10.10/11(t) partially covers Section 10.14.5.

Datum 10.10/11(u)	Source	Label	Number
Flexural stiffness used of a compression member.	X	EI	
Modulus of elasticity of concrete, psi.	X	E_c	
Modulus of elasticity of reinforcement, psi.	X	E_s	
Moment of inertia of gross concrete section about centroidal axis, neglecting reinforcement.	X	I_g	
Moment of inertia of reinforcement about centroidal axis.	X	I_{se}	
Ratio of maximum factored dead load moment to maximum factored total load moment, always positive.	X	β_d	

DLT 10.10/11(u) EI		1	2	3	4	
C1	$EI = (E_c I_g/5 + E_s I_{se})/(1 + \beta_d)$?	Y	N	N	N	E L S E
C2	$EI = (E_c I_g/2.5)/(1 + \beta_d)$?	N	Y	N	N	
C3	EI determined by accurate calculation?	N	N	Y	N	
A1	Provisions = satisfied	X	X	X		
A2	Provisions ≠ satisfied				X	
A3	DLT Ch 10	X	X	X	X	
A4	Logical Error					X

Comment: 1) DLT 10.10/11(u) covers Section 11.5.2.

Section 10.12 Map



Section 10.12 Axially Loaded Members Supporting Slab System

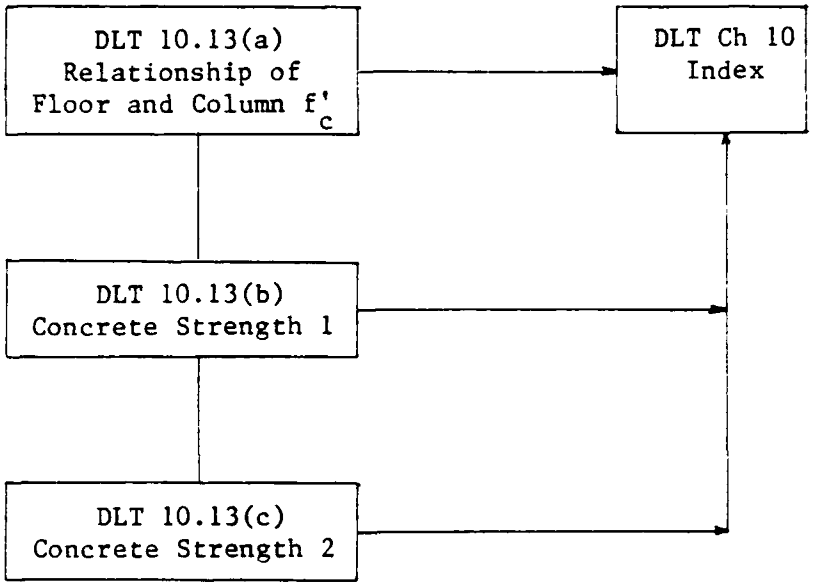
Datum 10.12(a)	Source	Label	Number
If slab system is included within the scope of Section 13.1	X		
If the column is designed as provided in Ch 10.	X		
If the column is designed in accordance with the additional requirements of Ch 13.	X		

DLT 10.12(a)	Slab Support Columns	1	2	3	4
C1	Slab system included within the scope of Section 13.1?	I	N	Y	I
C2	Column designed as provided in Ch 10?	Y	Y	Y	N
C3	Column designed in accordance with the additional requirements of Ch 13?	Y	N	N	I
A1	Provisions = satisfied	X	X		
A2	Provisions ≠ satisfied			X	X
A3	DLT Ch 10				

Comments: 1) DLT 10.12(a) covers Section 10.12.

2) Condition 2 may be unnecessary.

Section 10.13 Map



Section 10.13 Transmission of Column Loads Through Floor System

Datum 10.13(a)	Source	Label	Number
Specified compressive strength of concrete, psi, in the column.	X	$f'_{c,column}$	
Specified compressive strength of concrete, psi, in the floor system.	X	$f'_{c,floor}$	

DLT 10.13(a)	Relationship of Floor and Column f'_c	1	2
C1	$f'_{c,col.} > 1.4\ f'_{c,floor}$?	Y	N
A1	DLT 10.13(b)	X	
A2	No provision, DLT Ch 10		X

Comment: 1) DLT 10.13(a) covers the introduction to Section 10.13.

Datum 10.13(b)	Source	Label	Number
If column is laterally supported on 4 sides by beams of approximately the same depth or by slabs.	X		
If strength of column is based on an assumed concrete strength in the column joint = 75% of column concrete + 35% of floor concrete strength.	X		

DLT 10.13(b)	Concrete Strength 1	1	2	3
C1	Columns laterally supported on four sides by beams of approximately equal depth or slabs?	Y	Y	N
C2	Strength of column based on assumed concrete strength in the column joint = 75% of column concrete strength + 35% floor concrete strength?	Y	N	I
A1	Provisions = satisfied	X		
A2	DLT 10.13(c)		X	X
A3	DLT Ch 10	X		

Comment: 1) DLT 10.13(b) covers Section 10.13.3.

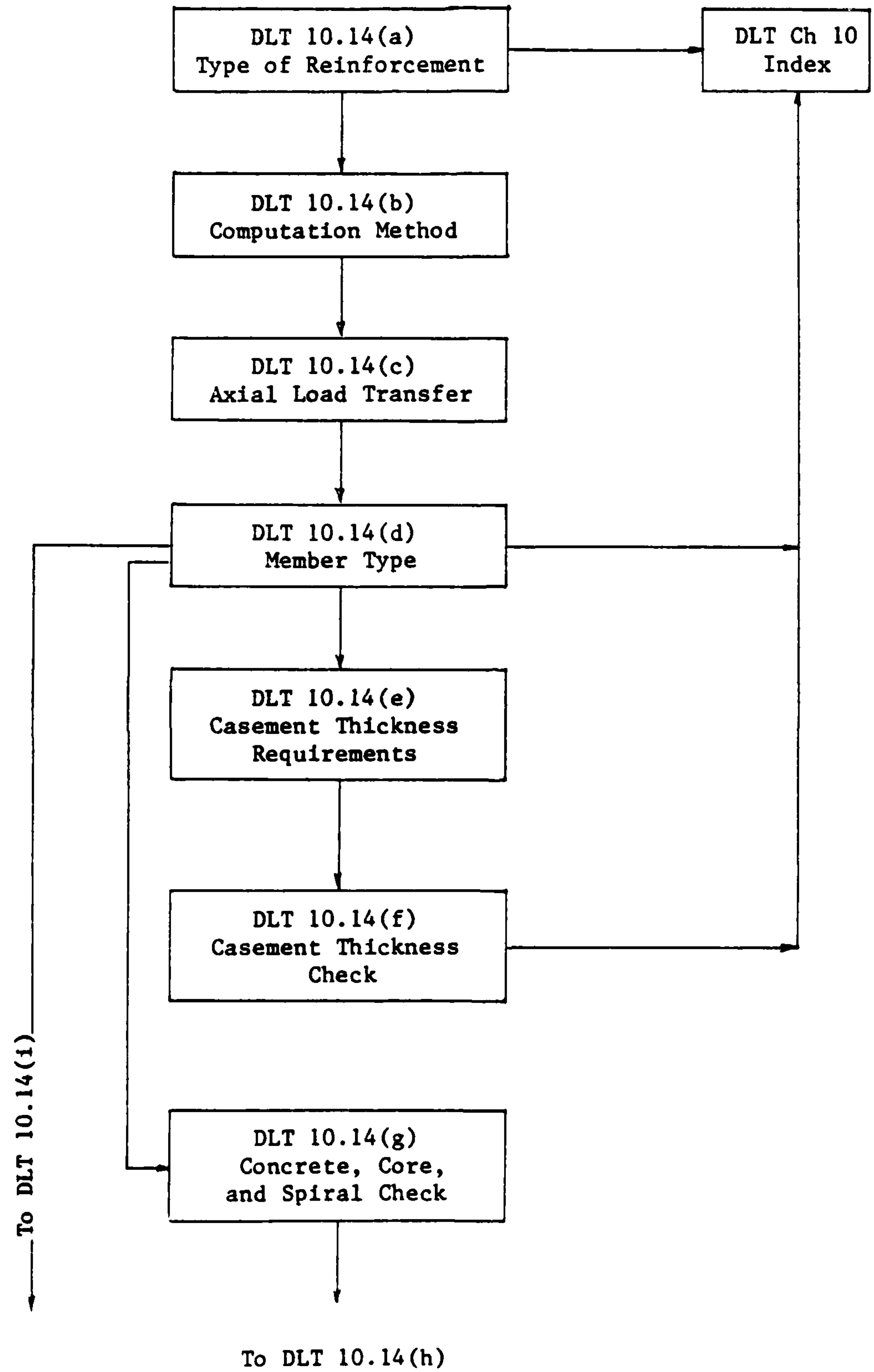
Datum 10.13(c)	Source	Label	Number
If strength of column through a floor system is based on $\min[f'_{c,col.}, f'_{c,floor}]$.	X		
If vertical dowels and spirals are used as required.	X		
Specified compressive strength of concrete, psi, in the column.	X	$f'_{c,col.}$	
Specified compressive strength of concrete, psi, in the floor.	X	$f'_{c,floor}$	
If concrete with strength = $f'_{c,col.}$ is placed in the floor about the column for an area = 4 times the column area.	X		
If the column concrete is well integrated into the floor concrete and placed in accordance with Sections 6.4.5 and 6.4.6.	X		

DLT 10.13(c)	Concrete Strength 2	1	2	3	4	
C1	Strength of column through a floor system based on $\min(f'_{c,col.}, f'_{c,floor})$ with vertical dowels and spirals as required?	Y	N	N	N	E L S E
C2	Concrete with strength = $f'_{c,col.}$ placed in the floor about the column for an area = 4 times the column area?	N	Y	Y	N	
C3	Column concrete well integrated into floor concrete and placed in accordance with Sections 6.4.5 and 6.4.6?		Y	N		
A1	Provisions = satisfied	X	X			
A2	Provisions ≠ satisfied			X	X	
A3	DLT Ch 10	X	X	X	X	
A4	Logical Error					X

Comments: 1) DLT 10.13(c) covers Sections 10.13.1 and 10.13.2.

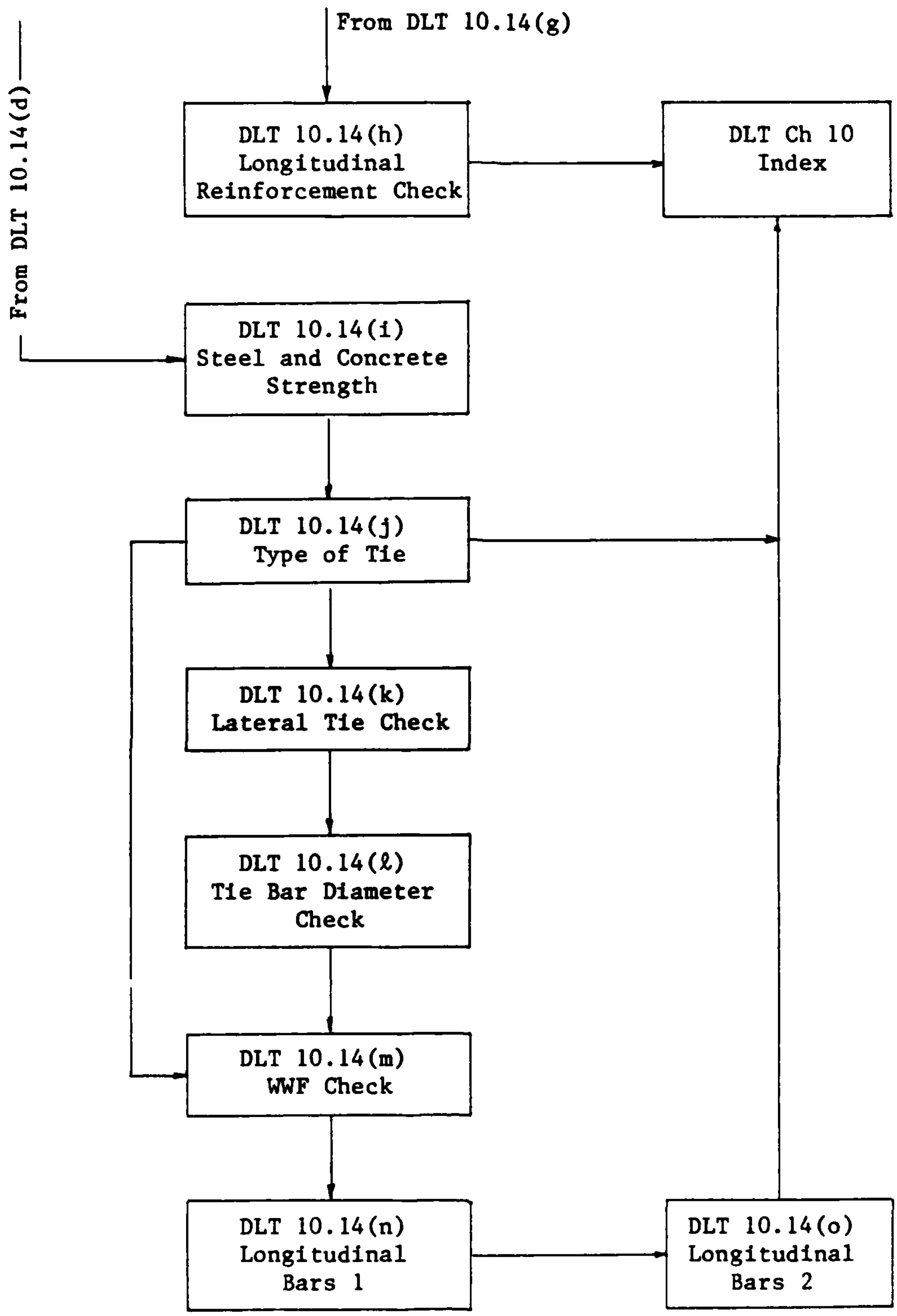
2) It seems possible that requirements C1 and C2 above could be simultaneously satisfied, but this DLT does not admit that case.

Section 10.14 Map



(Continued)

Section 10.14 Map (Concluded)



Section 10.14 Composite Compression Members

Datum 10.14(a)	Source	Label	Number
Type of longitudinal reinforcement.	X		

DLT 10.14(a) Type of Reinforcement		1	2
C1	Compression member longitudinally reinforced with structural steel shapes, pipes, or tubing?	Y	N
C2	Compression member longitudinally reinforced with bars?	I	I
A1	DLT 10.14(b)	X	
A2	DLT Ch 10		X

Comments: 1) DLT 10.14(a) covers Section 10.14.1.

2) This DLT will admit only members reinforced per C1 above as composite members. It is not perfectly clear from the phraseology in Section 10.14.1 if this is correct.

Datum 10.14(b)	Source	Label	Number
If strength is computed for the same limiting conditions applicable to ordinary reinforced concrete members.	X		

DLT 10.14(b)	Computation Method	1	2
C1	Strength computed for the same limiting conditions applicable to ordinary reinforced concrete members?	Y	N
A1	Provisions = satisfied	X	
A2	Provisions ≠ satisfied		X
A3	DLT 10.14(c)	X	X

Comment:

1) DLT 10.14(b) covers Section 10.14.2.

Datum 10.14(c)	Source	Label	Number
Method of transferring axial load assigned to concrete to the concrete.	X		
Method of transferring axial load not assigned to concrete to the structural shape, pipe, or tube.	X		

	DLT 10.14(c) Axial Load Transfer	1	2	3
C1	Axial load assigned to concrete transferred to the concrete by members or brackets in direct bearing on the composite member concrete?	Y	Y	N
C2	Axial load not assigned to concrete developed by direct connection to the structural steel shape, pipe, or tube?	Y	N	I
A1	Provisions = satisfied	X		
A2	Provisions ≠ satisfied		X	X
A3	DLT 10.14(d)	X	X	X

Comments: 1) DLT 10.14(c) covers Sections 10.14.3 and 10.14.4.

2) Section 10.14.5 is covered in the 10/11 DLT series.

Datum 10.14(d)	Source	Label	Number
Type of composite member.	X		

DLT 10.14(d) Member Type		1	2	3	4	
C1	Structural steel encased concrete core?	Y	N	N	N	E
C2	Spiral reinforcement around structural steel core?	N	Y	N	N	L
						S
C3	The reinforcement around structural steel core?	N	N	Y	N	E
A1	DLT 10.14(e)	X				
A2	DLT 10.14(g)		X			
A3	DLT 10.14(i)			X		
A4	No provisions, DLT Ch 10				X	
A5	Logical Error					X

Datum 10.14(e)	Source	Label	Number
Shape of cross section.	X	h	
Diameter of circular section.	X		
Face widths of each face of non-circular section.	X	b	
Specified yield strength of non-prestressed reinforcement, psi.	X	f_y	
Modulus of elasticity of reinforcement, psi.	X	E_s	

DLT 10.14(e)	Casement Thickness Requirements	1	2
C1	Circular section?	Y	N
A1	$t'_{se} = b[f_y/3E_s]^{\frac{1}{2}}$		X
A2	$t'_{se} = h[f_y/8E_s]^{\frac{1}{2}}$	X	
A3	DLT 10.14(f)	X	X

Comments: 1) DLT 10.14(e) provides the minimum requirements for structural steel encasement found in Section 10.14.6.1.

2) This DLT reflects the assumptions of Section 10.14.6 regarding cross section shape, i.e., non-circular sections are faceted sections. The possibility of oblong or other non-circular, non-faceted sections is not admitted.

3) Note that t'_{se} must be determined for each face of non-circular sections. A counting system will be needed to enable automation.

Datum 10.14(f)	Source	Label	Number
Thickness of steel encasement used.	X	t_{se}	
Thickness of steel encasement required.	DLT 10.14(e)	t'_{se}	
If longitudinal bars located within the concrete core are considered in computing A_t and I_t.	X		

DLT 10.14(f) Casement Thickness Check		1	2
C1	$t_{se} \geq t'_{se}$?	Y	N
C2	Longitudinal bars located within the concrete are considered in computing A_t and I_t?	I	I
A1	Provisions = satisfied	X	
A2	Provisions ≠ satisfied		X
A3	DLT Ch 10	X	X

Comments: 1) DLT 10.14(f) covers Sections 10.14.6.1 and 10.14.6.2.

2) In the case of non-circular sections, as previously defined, the comparison of C1 above must be made for each face.

3) Definition: A_t = area of structural steel shape, pipe or tubing in a composite section, sq in. I_t = moment of inertia of structural steel shape, pipe or tubing about centroidal axis of composite member cross section.

Datum 10.14(g)	Source	Label	Number
Specified compressive strength of concrete, psi.	X	f'_c	
Yield strength, used in deisgn, for structural steel core.	X		
Specified minimum yield strength for grade of structural steel used.	X	f_y	
If requirements for ρ_s are satisfied.	DLT 10.9(c)		

	DLT 10.14(g) Concrete, Core, and Spiral Check	1	2	3	4
C1	$f'_c \geq 2500$ psi?	Y	Y	Y	N
C2	Design yield strength of structural steel core = min[f_y, 50000 psi] ?	Y	Y	N	I
C3	Requirements for ρ_s = satisfied?	Y	N	I	I
A1	Provisions = satisfied	X			
A2	Provisions ≠ satisfied		X	X	X
A3	DLT 10.14(h)	X	X	X	X

Comment: 1) DLT 10.14(g) covers Sections 10.14.7.1, 10.14.7.2, and 10.14.7.3.

Datum 10.14.(h)	Source	Label	Number
Location of longitudinal bars with respect to the spiral.	X		
Net area of concrete section.	X	A_{nc}	
Total area of longitudinal reinforcement, sq in.	X	A_{st}	
If the area of the longitudinal bars is considered in computing A_t and I_t.	X		

DLT 10.14(h)	Longitudinal Reinforcement Check	1	2	3	
C1	Longitudinal bars located within the spiral?	Y	Y	N	ELSE
C2	$0.01\ A_{nc} \leq A_{st} \leq 0.08\ A_{nc}$?	Y	N		
C3	A_{st} considered in computing A_t and I_t?	I	I		
A1	Provisions = satisfied	X			
A2	Provisions ≠ satisfied		X		
A3	DLT Ch 10			X	
A4	Logical Error				X

Comments: 1) DLT 10.14(h) covers Sections 10.14.7.4 and 10.14.7.5.

2) It is more precise phraseology to refer to area of longitudinal bars rather than longitudinal bars in both Sections.

3) Definitions: A_t = area of structural steel shape, pipe or tubing in a composite section, sq in. I_t = moment of inertia of structural steel shape, pipe or tubing about centroidal axis of composite member cross section.

Datum 10.14(i)	Source	Label	Number
Specified strength of concrete, psi.	X	f'_c	
Design yield strength of structural steel core, psi.	X		
Specified yield strength for grade of structural steel used, psi.	X	f_y	

DLT 10.14(i)	Steel and Concrete Strength	1	2	3
C1	$f'_c \geq 2500$ psi?	Y	Y	N
C2	Design yield strength of structural steel core = $\min\left[f_y, 50000 \text{ psi}\right]$?	Y	N	I
A1	Provisions = satisfied	X		
A2	Provisions ≠ satisfied		X	
A3	DLT 10.14(j)	X	X	X

Comment: 1) DLT 10.14(i) covers Sections 10.14.8.1 and 10.14.8.2.

Datum 10.14(j)	Source	Label	Number
Type of tie reinforcement.	X		

DLT 10.14(j) Type of Tie		1	2	3	4
C1	Tie reinforcement = lateral ties?	Y	N	N	Y
C2	Tie reinforcement = welded wire fabric?	N	Y	N	Y
A1	DLT 10.14(k)	X			
A2	DLT 10.14(m)		X		
A3	No Provision, DLT Ch 10			X	X

Comment:

1) DLT 10.14(j) partially covers Section 10.14.8.4.

Datum 10.14(k)	Source	Label	Number
Configuration of lateral ties.	X		
Vertical spacing of lateral ties.	X		
Diameter of longitudinal bars.	X		
Diameter of tie bars.	X		
Least side dimension of composite member.	X		

DLT 10.14(k)	Lateral Tie Check	1	2	3
C1	Lateral ties extend completely around the structural steel core?	Y	Y	N
C2	Vertical spacing of lateral ties ≤ min[16 longitudinal bar diameters, 48 tie bar diameters, ½ times the least side dimension of the composite member] ?	Y	N	I
A1	Provisions = satisfied	X		
A2	Provisions ≠ satisfied		X	X
A3	DLT 10.14(ℓ)	X	X	X

Comments: 1) DLT 10.14(k) covers Sections 10.14.8.3 and 10.14.8.5.

2) It is assumed in the Code and here as well that all longitudinal bars have the same diameter.

Datum 10.14(ℓ)	Source	Label	Number
Greatest side dimension of composite members.	X		
Diameter of lateral tie bar.	X		

DLT 10.14(ℓ)	Tie Bar Diameter Check	1	2	3
C1	Bar diameter $\geq$ max[1/50 times greatest side dimension, 3/8 in.] ?	Y	N	N
C2	Bar diameter $\geq$ 5/8 in.?	I	Y	N
A1	Provisions = satisfied	X	X	
A2	Provisions $\neq$ satisfied			X
A3	DLT 10.14(m)	X	X	X

Comment:

1) DLT 10.14(ℓ) partially covers Section 10.14.8.4.

Datum 10.14(m)	Source	Label	Number
Area of welded wire fabric per allowable spacing of lateral tie bars.	X		
Area of lateral tie bars per allowable lateral tie bar spacing.	X		

DLT 10.14(m) Welded Wire Fabric Check		1	2
C1	Area of welded wire fabric $\geq$ area of lateral ties at their allowable spacing?		
A1	Provisions = satisfied	X	
A2	Provisions ≠ satisfied		X
A3	DLT 10.14(n)	X	X

Comments: 1) DLT 10.14(m) partically covers Section 10.14.8.4.

2) One must determine an acceptable design for lateral ties in order to use an "equivalent area of welded wire fabric". This includes spacing of ties per Section 10.14.8.5.

3) It is not stated, but must be assumed, that only the horizontal wires of the WWF are included as tie area.

Datum 10.14(n)	Source	Label	Number
Location of longitudinal bars with respect to the ties.	X		
Net area of concrete section.	X	A_{nc}	
Total area of longitudinal reinforcement, sq in.	X	A_{st}	
If the area of longitudinal bars is considered in computing A_t for strength.	X		
If the area of longitudinal bars is considered in computing I_t for slenderness effects.	X		

DLT 10.14(n)	Longitudinal Bars 1	1	2	3	4
C1	Longitudinal bars located within the ties?	Y	Y	Y	N
C2	$0.01\ A_{nc} \leq A_{st} \leq 0.08\ A_{nc}$?	Y	Y	N	I
C3	Longitudinal bars considered in computing A_t for strength?	I	I	I	I
C4	Longitudinal bars considered in computing I_t for evaluation of slenderness effects?	N	Y	I	I
A1	Provisions = satisfied	X			
A2	Provisions ≠ satisfied		X	X	X
A3	DLT 10.14(o)	X	X	X	X

Comments: 1) DLT 10.14(n) covers Sections 10.14.8.6 and 10.14.8.8.

2) The Code states the use of A_t and I_t in Section 10.14.8.8, but not in Section 10.14.7.5.

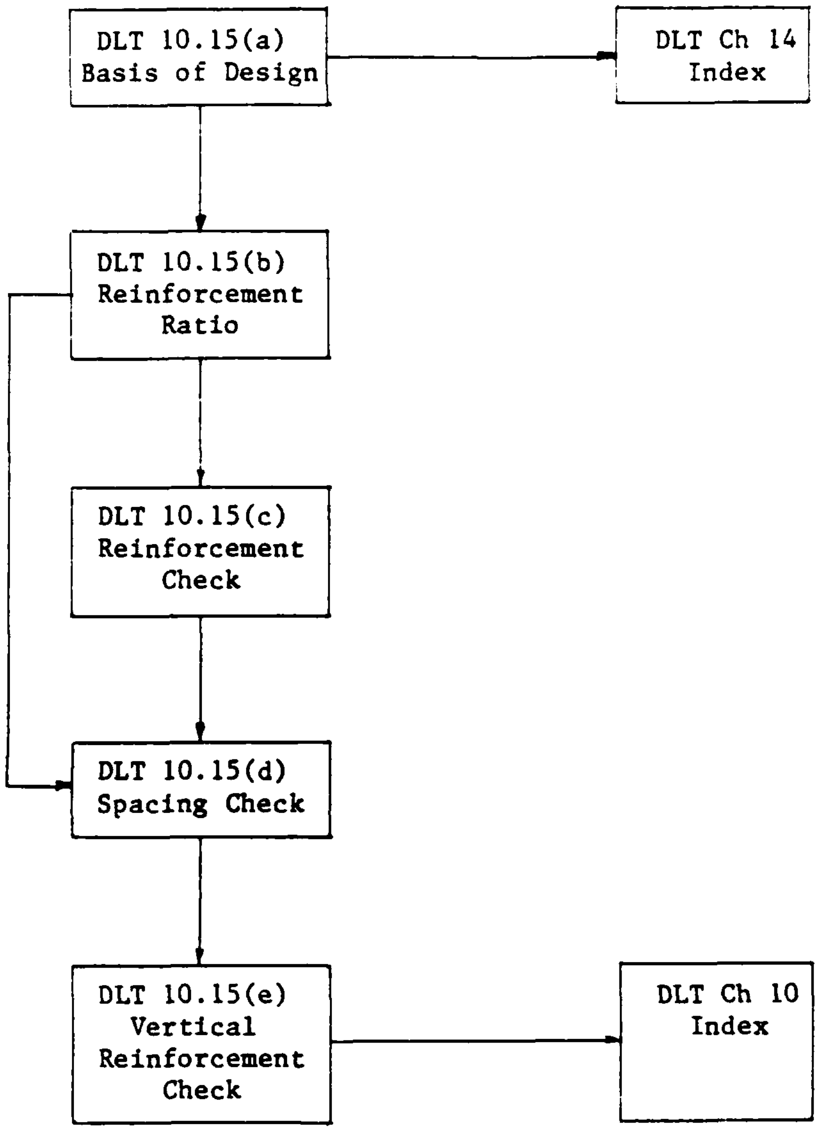
Datum 10.14(o)	Source	Label	Number
Location and spacing of longitudinal bars.	X		

DLT 10.14(o)	Longitudinal Bars 2	1	2	3
C1	Longitudinal bars located at every corner of a rectangular cross section?	Y	Y	N
C2	Longitudinal bars placed at spacing $\leq \frac{1}{2}$ least side dimension?	Y	N	I
A1	Provisions = satisfied	X		
A2	Provisions $\neq$ satisfied		X	X
A3	DLT Ch 10	X	X	X

Comments: 1) DLT 10.14(o) covers Section 10.14.8.7.

2) This Section was interpreted to require longitudinal bars. It may be that the spacing requirement (C2 above) applies only if additional bars are used.

Section 10.15 Map



Section 10.15 Special Provisions for Walls

Datum 10.15(a)	Source	Label	Number
If wall is designed as a compression member in accordance with provisions of Chapter 10?	X		

DLT 10.15(a) Basis of Design		1	2
C1	Wall designed as a compression member in accordance with provisions of Chapter 10?	Y	N
A1	DLT 10.15(b)	X	
A2	DLT Chapter 14		X

Comments:

1) DLT 10.15(a) covers Section 10.15.1.

2) The phrase "as a compression member" was taken from the Commentary and does not appear in the Code. It provides the reason for the subsequent requirements.

Datum 10.15(b)	Source	Label	Number
Reinforcement type.	X		
Diameter of bar or wire.	X	d_b	
Specified yield strength of non-prestressed reinforcement, psi.	X	f_y	

	DLT 10.15(b) Reinforcement Ratios	1	2	3	4	5	6	
C1	Reinforcement = deformed bars?	Y	Y	Y	N	N	N	E
C2	Reinforcement = welded wire fabric?	N	N	N	Y	Y	N	L
C3	d_b > 5/8 in.?	Y	N	N	Y	N		S
C4	f_y < 60000 psi?	I	Y	N	I	I		E
A1	A_{vt}/A_g(min) = 0.0012			X		X		
A2	A_{vt}/A_g(min) = 0.0015	X	X					
A3	A_h/A_g(min) = 0.0020			X		X		
A4	A_h/A_g(min) = 0.0025	X	X					
A5	No provision for min ratio, DLT 10.15(d)				X		X	
A6	DLT 10.15(c)	X	X	X		X		
A7	Logical Error							X

Comments:

1) DLT 10.15(b) covers Sections 10.15.2 and 10.15.5.
2) This DLT produces two data.
3) Diameter is used in reference to wire size as well as bar size for consistency.

Datum 10.15(c)	Source	Label	Number
Ratio of vertical reinforcement area to gross concrete area used.	X	A_{vt}/A_g	
Ratio of horizontal reinforcement area to gross concrete area used.	X	A_h/A_g	
Minimum ratio of vertical reinforcement area to gross concrete area.	DLT 10.15(b)	A_{vt}/A_g (min)	
Minimum ratio of horizontal reinforcement area to gross concrete area.	DLT 10.15(b)	A_h/A_g (min)	

DLT 10.15(c)	Reinforcement Ratio Check	1	2	3
C1	$A_{vt}/A_g \geq A_{vt}/A_g$ (min)?	Y	Y	N
C2	$A_h/A_g \geq A_h/A_g$ (min)?	Y	N	I
A1	Provisions = satisfied	X		
A2	Provisions ≠ satisfied		X	X
A3	DLT 10.15(d)	X	X	X

Comment: 1) DLT 10.15(c) covers Sections 10.15.2 and 10.15.5.

Datum 10.15(d)	Source	Label	Number
Spacing of reinforcement, in.	X		
Wall thickness, in.	X	t_w	

DLT 10.15(d)	Spacing Check	1	2
C1	Spacing of reinforcement $\leq$ min[$3t_w$, 18 in.] ?	Y	N
A1	Provisions = satisfied	X	
A2	Provisions $\neq$ satisfied		X
A3	DLT 10.15(e)	X	X

Comment:

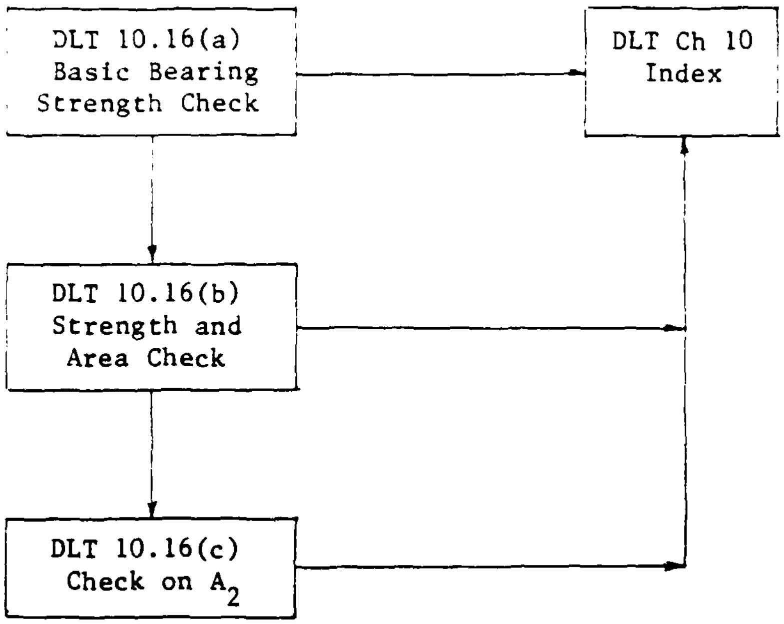
1) DLT 10.15(d) covers Sections 10.15.3 and 10.15.6.

Datum 10.15(e)	Source	Label	Number
Area of vertical reinforcement.	X	A_{vt}	
Gross area of section, sq in.	X	A_g	
If vertical reinforcement is required as compression reinforcement.	X		
If vertical reinforcement is enclosed by ties.	X		

DLT 10.15(e)	Vertical Reinforcement Check	1	2	3	4
C1	$A_{vt} \leq 0.01\ A_g$?	Y	I	Y	N
C2	Vertical reinforcement required as compression reinforcement?	N	I	Y	I
C3	Vertical reinforcement enclosed by ties?	N	Y	N	N
A1	Provisions = satisfied	X	X		
A2	Provisions ≠ satisfied			X	X
A3	DLT Ch 10	X	X	X	X

Comment: 1) DLT 10.15(e) covers Section 10.15.4.

Section 10.16 Map



Section 10.16 Bearing Strength

Datum 10.16(a)	Source	Label	Number
If bearing is at post-tensioning anchorages.	X		
Design bearing strength.	X		
Strength reduction factor.	X	ϕ	
Specified compressive strength of concrete, psi.	X	f'_c	
Loaded area.	X	A_1	

DLT 10.16(a)	Basic Bearing Strength Check	1	2	3
C1	Bearing at post-tensioning anchorage?	N	N	Y
C2	Design bearing strength $\leq \phi[0.85f'_c A_1]$?	Y	N	I
A1	Provisions = satisfied, DLT Ch 10	X		
A2	DLT 10.16(b)		X	
A3	Section 10.16 does not apply, DLT Ch 10			X

Comment: 1) DLT 10.16(a) covers Sections 10.16.1 and 10.16.2.

Datum 10.16(b)	Source	Label	Number
Maximum area of the portion of the supporting surface that is geometrically similar to & concentric with the loaded area.	X	A_2	
Loaded area.	X	A_1	
Specified compressive strength of concrete, psi.	X	f'_c	
If supporting surface is wider on all sides than the loaded area.	X		

DLT 10.16(b)	Strength and Area Check - 1	1	2	3	
C1	Supporting surface wider on all sides than the loaded area?	Y	Y	N	ELSE
C2	Design bearing strength on concrete $\leq \{\min[\sqrt{A_2/A_1}, 2]\}\{\phi[0.85f'_c A_1]\}$?	Y	N		
A1	Provisions = satisfied	X			
A2	Provisions ≠ satisfied			X	
A3	DLT 10.16(c)		X		
A4	DLT Ch 10	X		X	
A5	Logical Error				X

Comments: 1) DLT 10.16(b) covers Section 10.16.1.1.

2) Note that if the supporting surface is not wider on all sides than the loaded area, then A_2 as defined in the Code and illustrated in the Commentary cannot exist.

Datum 10.16(c)	Source	Label	Number
Loaded area.	X	A_1	
Area of the lower base of the largest frustum of a right pyramid or core contained wholly within the support and having for its upper base the loaded area and having side slopes of 1 verticle to 2 horizontal.	X	$\overline{A}_2$	
If top of support is stepped or sloped.	X		
Specified compressive strength of concrete, psi.	X	f'_c	
Strength reduction factor.	X	ϕ	

DLT 10.16(c)	Strength and Area Check - 2	1	2	3	
C1	Top of support sloped or stepped?	Y	Y	N	E L S E
C2	Design bearing strength on concrete $\leq \{\min[\sqrt{\overline{A}_2/A_1},\ 2]\}\{\phi[0.85f'_c A_1]\}$?	Y	N	N	
A1	Provisions = satisfied	X			
A2	Provisions ≠ satisfied		X	X	
A3	DLT Ch 10	X	X	X	
A4	Logical Error				X

Comments:

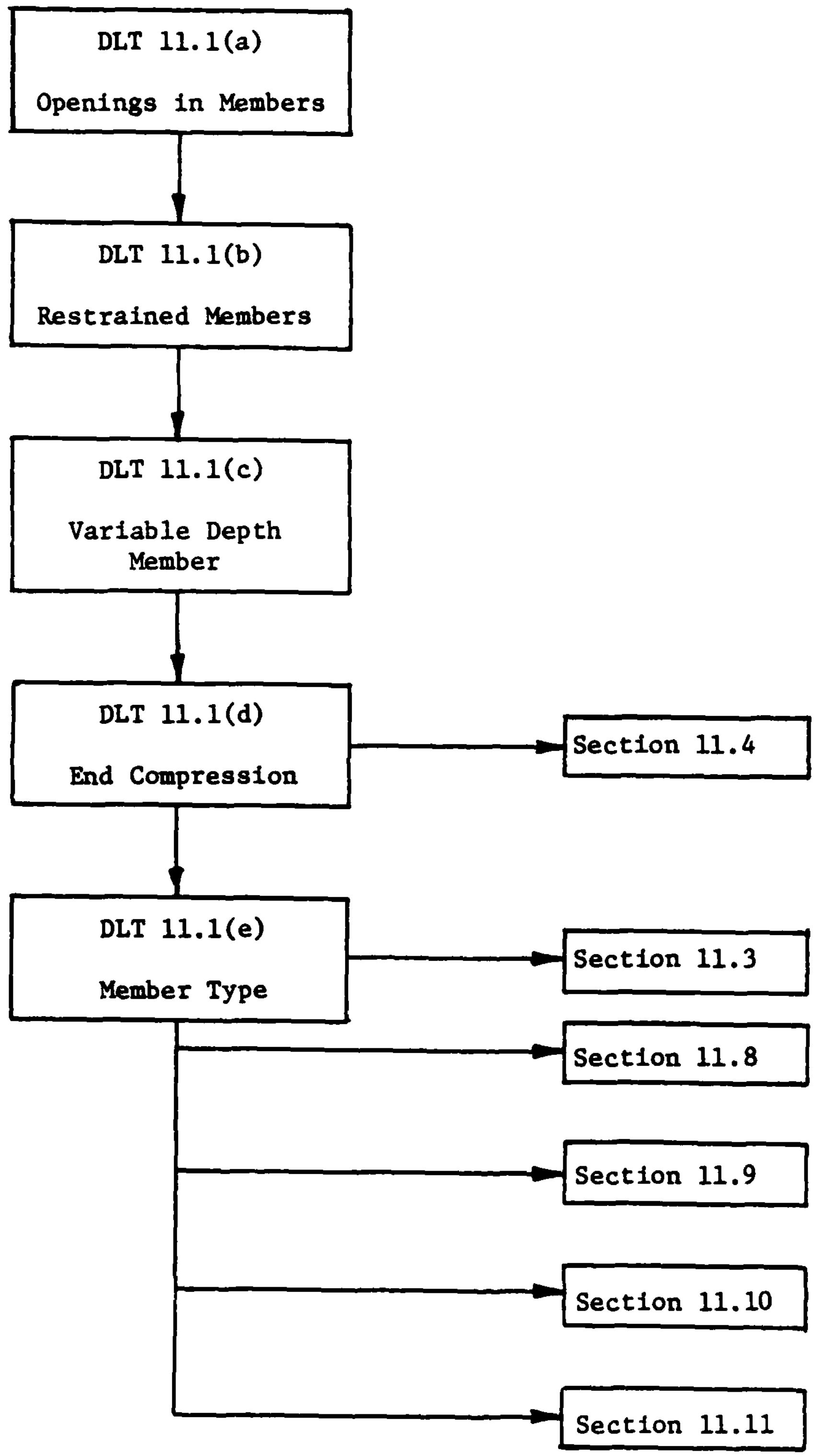
1) DLT 10.16(c) covers Section 10.16.1.2.

2) If the top of the support is not sloped or stepped, then $\overline{A}_2 = A_2$ and the response to C2 must be N to be compatible with DLT 10.16(b).

DLT Chapter 11-1		1	2	3	4	5	6	7	
C1	Shear strength ?	Y	N	N	N	N	N	N	E
C2	Lightweight concrete ?	N	Y	N	N	N	N	N	L
C3	Shear strength provided by concrete for non-prestressed members?	N	N	Y	N	N	N	N	S
C4	Shear strength provided by concrete for prestressed members?	N	N	N	Y	N	N	N	E
C5	Shear strength provided by shear reinforcement?	N	N	N	N	Y	N	N	
C6	Combined shear and torsion strength for nonprestressed members with rectangular or flanged sections?	N	N	N	N	N	Y	N	
A1	Section 11-1	X							
A2	Section 11-2		X						
A3	Section 11-3			X					
A4	Section 11-4				X				
A5	Section 11-5					X			
A6	Section 11-6						X		
A7	DLT Chapter 11-2							X	
A8	Logical Error								X

DLT Chapter 11-2		1	2	3	4	5	6	7	
C7	Shear friction?	Y	N	N	N	N	N	N	E
C8	Special provisions for deep flexural members?	N	Y	N	N	N	N	N	L
C9	Special provisions for brackets and corbels?	N	N	Y	N	N	N	N	S
C10	Special provisions for walls?	N	N	N	Y	N	N	N	E
C11	Special provisions for slabs and footings?	N	N	N	N	Y	N	N	
C12	Transfer of moments to columns?	N	N	N	N	N	Y	N	
A1	Section 7	X							
A2	Section 8		X						
A3	Section 9			X					
A4	Section 10				X				
A5	Section 11					X			
A6	Section 12						X		
A7	DLT 318-77 Index							X	
A8	Logical Error								X

Section 11.1 Map



Section 11.1 Shear Strength

Datum 11.1(a)	Source	Label	Number
If effects of openings in members considered in determining shear strength	X		

DLT 11.1(a) Openings in Members		1	2
C1	Effects of openings in members considered in determining shear strength?	Y	N
A1	Provision = satisfied	X	
A2	Provision ≠ satisfied		X
A3	DLT 11.1(b)	X	X

Comment:

1) DLT 11.1(a) partially covers Section 11.1.1.1.

Datum 11.1(b)	Source	Label	Number
If member is restrained	X		
If effects of axial tension due to creep and shrinkage considered in determining shear strenth Vc	X		

DLT 11.1(b) Restrained Member		1	2	3	4
C1	Restrained member?	Y	Y	N	E L S E
C2	Effects of axial tension due to creep and shrinkage considered in determining shear strength Vc?	Y	N		
A1	Provision = satisfied	X			
A2	Provision ≠ satisfied		X		
A3	DLT 11.1(c)	X	X	X	
A4	Logical error				X

Comment:

1) DLT 11.1(b) partially covers Section 11.1.1.2.

Datum 11.1(c)	Source	Label	Number
Member configuration	X		
If inclined flexural compression present	X		
If effects of inclined flexural compression were considered in determining shear strength Vc.	X		

DLT 11.1(c)	Variable Depth Member	1	2	3	4
C1	Variable depth member?	Y	Y	N	E
C2	Inclined flexural compression present?	Y	N		L
C3	Effects of inclined flexural compression considered in determining shear strength Vc?	I			S E
A1	Provision = satisfied	X			
A2	DLT 11.1(d)	X	X	X	
A3	Logical error				X

Comment:

1) DLT 11.1(c) partially covers Section 11.1.1.2.

Datum 11.1(d)	Source	Label	Number
If reaction, in direction of applied shear, introduces compression into the end regions of a member	X		
If member is prestressed	X		
If, for nonprestressed members, sections located less than a distance d from the face of support designed for the same shear Vu as that computed at a distance d	X		
If, for prestressed members, sections located less than a distance h/2 from face of support designed for the same shear Vu as that computed at a distance h/2	X		

	DLT 11.1(d) End Compression	1	2	3	4	
C1	Does reaction, in direction of applied shear, introduce compression into the end regions of a member?	Y	Y	N	N	E
C2	Member prestressed?	Y	N	Y	N	L S
C3	Sections located less than a distance d from the face of support designed for the same shear Vu as that computed at a distance d?		I	I	I	E
C4	Sections located less than a distance h/2 from the face of support designed for the same shear Vu as that computed at a distance h/2?	I		I	I	
A1	Provision = satisfied	X	X			
A2	DLT 11.1(e)		X		X	
A3	Section 11.4	X		X		
A4	Logical error					X

Comment:

1) DLT 11.1(d) covers Sections 11.1.2, 11.1.2.1, 11.1.2.2.

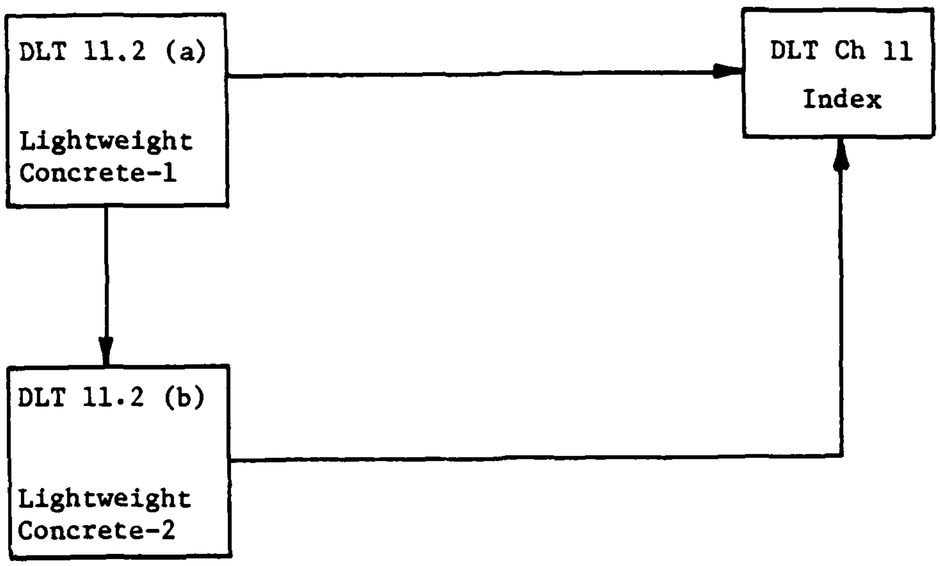
Datum 11.1(e)	Source	Label	Number
Member type	X		

	DLT 11.1(e) Member Type	1	2	3	4	5	6
C1	Deep flexural member?	Y	N	N	N	N	E
C2	Bracket or corbel?	N	Y	N	N	N	L
C3	Wall?	N	N	Y	N	N	S
C4	Slab of footing?	N	N	N	Y	N	E
A1	Section 11.8	X					
A2	Section 11.9		X				
A3	Section 11.10			X			
A4	Section 11.11				X		
A5	Section 11.3					X	
A6	Logical error						X

Comments: 1) DLT 11.1(e) covers Section 11.1.3.

2) The Code does not specifically state that Sections 11.8-11.11 apply to non-prestressed concrete. It is assumed that if concrete is prestressed, Section 11.4 must be used in determining Vc for all member types.

Section 11.2 Map



Section 11.2 Lightweight Concrete

Datum 11.2 (a)	Source	Label	Number
Type of concrete	X		
If f_{ct} was specified	X		
If concrete was proportioned in accordance with Section 4.2. Average splitting tensile strength of lightweight concrete, psi.	X	f_{ct}	
Square root of specified compressive strength of concrete, psi.	X	$\sqrt{f'_c}$	
If provisions for Vc and Tc were modified by substituting $f_{ct}/6.7$ for $\sqrt{f'_c}$	X		

DLT 11.2 (a) Lightweight Concrete - 1		1	2	3	4	5	
C1	Lightweight concrete used?	Y	Y	Y	Y	N	E
C2	f_{ct} specified?	Y	Y	Y	N		L
C3	Concrete proportioned in accordance with Section 4.2?	Y	Y	N	I		S
C4	$f_{ct}/6.7 > \sqrt{f'_c}$?	Y	N	I			E
C5	Provisions for Vc and Tc modified by substituting $f_{ct}/6.7$ for $\sqrt{f'_c}$?	I	Y	I			
A1	Provisions = satisfied		X				
A2	Provisions ≠ satisfied	X		X			
A3	DLT 11.2(b)				X		
A4	DLT Chapter 11	X	X	X		X	
A5	Logical Error						X

Comments:

1) DLT 11.2(a) covers Section 11.2.1 and 11.2.1.1.

2) One could infer from Sections 11.2.1.1 and 11.2.1.2 that concrete need not satisfy provisions of Section 4.2 when f_{ct} is not specified. See Decision Rule 4.

Datum 11.2(b)	Source	Label	Number
Type of lightweight concrete	X		
If values of $\sqrt{f'_c}$ affecting V_c, T_c, and M_{cr} were multiplied by 0.75, 0.85, or a factor based on linear interpolation.	X		

DLT 11.2(b) Lightweight Concrete - 2		1	2	3	4	5	6	7	8	9	
C1	All lightweight concrete?	Y	Y	Y	N	N	N	N	N	N	E
C2	Sand lightweight concrete?	N	N	N	Y	Y	Y	N	N	N	L
C3	Partial sand replacement used?	N	N	N	N	N	N	Y	Y	Y	S
C4	Values of $\sqrt{f'_c}$ affecting V_c, T_c, and M_{cr} multiplied by 0.75?	Y	N	N	Y	N	N	Y	N	N	E
C5	Values of $\sqrt{f'_c}$ affecting V_c, T_c, and M_{cr} multiplied by 0.85?	N	Y	N	N	Y	N	N	I	N	
C6	Values of $\sqrt{f'_c}$ affecting V_c, T_c, and M_{cr} multiplied by a factor based on linear interpolation?	N	N	I	N	N	I	N	N	Y	
A1	Provisions = satisfied	X				X		X		X	
A2	Provisions ≠ satisfied		X	X	X		X		X		
A3	DLT Chapter 11	X	X								
A4	Logical Error										X

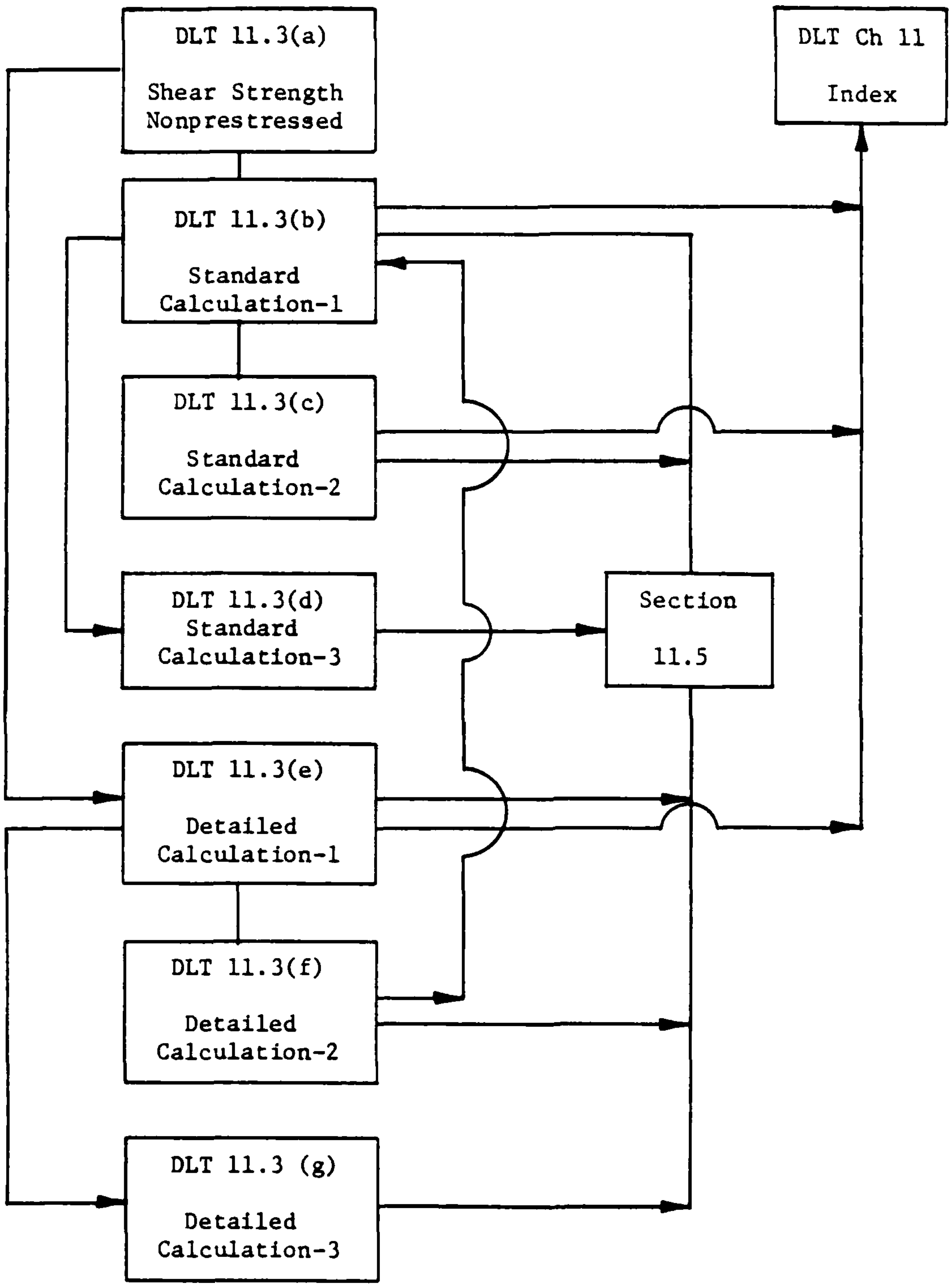
Comments:

1) DLT 11.2(b) covers Section 11.2.1.2.

2) It was assumed that multiplying $\sqrt{f'_c}$ by 0.75 is acceptable for the case of partial sand replacement. See Decision Rule 7.

3) DLT 11.2(a) established that lightweight concrete was used, hence (N,N,N) is not possible for C1, C2, and C3.

Section 11.3 Map



Section 11.3 Shear Strength Provided by Concrete for Nonprestressed Members

Datum 11.3(a)	Source	Label	Number
If detailed calculation of concrete shear strength is to be done	X		

DLT 11.3(a) Shear Strength - Nonprestressed		1	2
C1	Detailed calculation of concrete shear strength to be done?	Y	N
A1	DLT 11.3(b)		X
A2	DLT 11.3(e)	X	

Comment:

1) DLT 11.3(a) is a switching DLT for Section 11.3.1 or 11.3.2.

Datum 11.3(b)	Source	Label	Number
Type of load on member	X		

	DLT 11.3(b) Standard Calculation - 1	1	2	3	4	5	
C1	Member subject to shear and flexure only?	Y	N	N	N	N	E
C2	Member subject to axial compression in addition to shear and flexure?	N	Y	N	N	N	L
C3	Member subject to significant axial tension in addition to shear and flexure?	N	N	Y	N	N	S
C4	Member subject to torsion in addition to shear and flexure?	N	N	N	Y	N	E
A1	$V_c = 2\sqrt{f'_c}\, b_w d$	X					
A2*	$V_c = 2\left(1+ \frac{N_u}{2000A_g}\right)\sqrt{f'_c}\, b_w d$		X				
A3	V_c defined equal zero, DLT 11.3(c)			X			
A4	DLT 11.3(d)				X		
A5	Section 11.5	X	X				
A6	No provision for V_c, Section 11.5					X	
A7	Logical error						X

Comments:

1) DLT 11.3(b) covers Sections 11.3.1.1, 11.3.1.2, and part of Section 11.1.3.3.

2) It was assumed that torsions and axial tension or compression do not occur simultaneously.

---

* N_u/A_g is in psi.

Datum 11.3(c)	Source	Label	Number
If shear reinforcement is designed to carry total shear	X		

DLT 11.3(c)	Standard Calculation - 2	1	2
C1	Shear reinforcement designed to carry total shear?	Y	N
A1	Provisions = satisfied	X	
A2	Provisions ≠ satisfied		X
A3	Section 11.5	X	
A4	DLT Chapter 11		X

Comment:

1) DLT 11.3(c) partially covers Section 11.3.1.3.

Datum 11.3(d)	Source	Label	Number
Factored torsional moment at section	X	T_u	
Strength reduction factor	X	ϕ	
Specified compressive strength of concrete, psi	X	f'_c	
Web width, or diameter of circular section, in.	X	b_w	
Distance from extreme compression fiber to centroid of longitudinal tension reinforcement, but need not be less than 0.80h for prestressed member, in. (For circular sections, d need not be less than the distance from extreme compression fiber to centroid of tension reinforcement in opposite half of member).	X	d	
Torsional section properties	X	Ex^2y	
Factored shear force at section	X	V_u	

DLT 11.3(d)	Standard Calculation-3	1	2
C1	$T_u > \phi(0.5\sqrt{f'_c}b_wd$?	Y	N
A1*	$V_c = \dfrac{2\sqrt{f'_c}b_wd}{\sqrt{(1+(2.5C_t\frac{T_u}{V_u})^2}}$	X	
A2	$V_c = 2\sqrt{f'_c}b_wd$		X
A3	Section 11.5	X	X

Comments:

1) DLT 11.3(d) covers Section 11.3.2.1.

2) It is assumed here that if the response to C1 is No that T_u is ignored and V_c is given by Code Eq (11.3). See Section 11.6.1.

* $C_t = b_wd/Ex^2y$.

Datum 11.3(e)	Source	Label	Number
Member loads	X		
Gross area of section, sq in.	X	A_g	
Web width, or diameter of circular section, in.	X	b_w	
Distance from extreme compression fiber to centroid of longitudinal tension reinforcement, but need not be less than 0.80h for prestressed members, in. (For circular sections, d need not be less than the distance from extreme compression fiber to centroid of tension reinforcement in opposite half of member.)	X	d	
Specified compressive strength of concrete, psi	X	f'_c	
Factored axial load normal to cross section occurring simultaneously with V_u; compression positive, tension negative, and to include effects of tension due to creep and shrinkage	X	N_u	

(Continued)

DLT 11.3(e) Detailed Calculation - 1		1	2	3	4	
C1	Member subject to shear and flexure only?	Y	N	N	N	E
C2	Member subject to uniaxial compression in addition to shear and flexure?	N	Y	N	N	L
						S
C3	Member subject to significant axial tension?	N	N	Y	N	E
A1	DLT 11.3(f)	X				
A2	DLT 11.3(g)		X			
A3*	$V_c = 2(1+ \frac{N_u}{500A_g})\sqrt{f'_c}b_wd$			X		
A4	No provisions, DLT Chapter 11				X	
A5	Section 11.5			X		
A6	Logical error					X

Comment:

1) DLT 11.3(e) is a switching DLT and covers Section 11.3.2.3.

---

* N_u/A_g is in psi.

Datum 11.3(f)	Source	Label	Number
Distance from extreme compression fiber to centroid of longitudinal tension reinforcement, but need not be less than 0.80h for prestressed members, in. (For circular sections, d need not be less than the distance from extreme compression fiber to centroid of tension reinforcement in opposite half of member).	X	d	
Factored shear force at section	X	V_u	
Factored moment at section	X	M_u	
Web width, or diameter of circular section, in.	X	b_w	
Square root of specified compressive strength of concrete, psi	X	$\sqrt{f'_c}$	

DLT 11.3(f)	Detailed Calculation - 2	1	2
C1	$V_u d/M_u \leq 1.0$?	Y	N
A1*	$V_c = \min\left[\left(1.9\sqrt{f'_c} + 2500\rho_w \frac{V_u d}{M_u}\right) b_w d,\ 3.5\sqrt{f'_c} b_w d\right]$	X	
A2	Detailed calculation does not apply DLT 11.3(b)		X
A3	Section 11.5	X	

Comments:

1) DLT 11.3(f) covers Section 11.3.2.1.

2) If the response to C1 is No, then V_c must be determined by code Eq (11.4), i.e., DLT 11.3(b).

---

* $\rho_w = A_s/b_w d$.

Datum 11.3(g)	Source	Label	Number
Distance from extreme compression fiber to centroid of longitudinal tension reinforcement; but need not be less than 0.80h for prestressed members, in. (For circular sections, d need not be less than the distance from extreme compression fiber to centroid of tension reinforcement in opposite half of member.)	X	d	
Factored moment at section	X	M_u	
Factored axial load normal to cross section occuring simultaneously with V_u; to be taken as positive for compression, negative for tension, and to include effects of tension due to creep and shrinkage.	X	N_u	
Overall thickness of member, in.	X	h	
Square root of specified compressive strength of concrete, psi	X	$\sqrt{f'_c}$	
Factored shear force at section	X	V_u	
Modified moment	X	M_m	
Web width, or diameter of circular section, in.	X	b_w	
Gross area of section, sq in.	X	A_g	

(Continued)

DLT 11.3(g) Detailed Calculation - 3		1	2
C1	$M_m = M_u - N_u \frac{(4h-d)}{8} \leq 0?$	Y	N
A1*	$V_c = \min\left[(1.9\sqrt{f'_c} + 2500\rho_w \frac{V_u d}{M_m})b_w d,\ 3.5\sqrt{f'_c}b_w d\sqrt{1 + \frac{N_u}{500A_g}}\right]$		X
A2**	$V_c = 3.5\sqrt{f'_c}b_w d\sqrt{1 + \frac{N_u}{500A_g}}$	X	
A3	Section 11.5	X	X

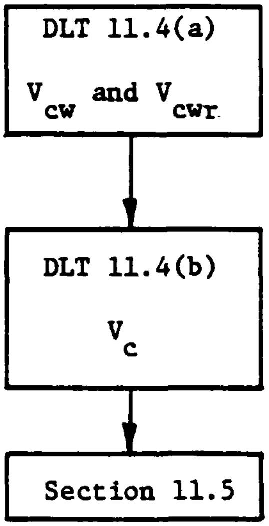
Comment:

1) DLT 11.3(g) covers Section 11.3.2.2.

* N_u/A_g is expressed in psi.

** $\rho_w = A_s/b_w d$.

Section 11.4 Map



Datum 11.4(a)	Source	Label	Number
Specified compressive strength of concrete, psi.	X	f'_c	
Compressive stress in concrete (after allowance for all prestress losses) at centroid of cross section resisting externally applied loads or at junction of web and flange when the centroid lies within the flange. (In a composite member, f_{pc} is resultant compressive stress at centroid of composite section, or at junction of web and flange when the centroid lies within the flange, due to both prestress and moments resisted by precast member acting alone.)	X	f_{pc}	
f_{pc} reduced* if section at a distance $h/2$ (h = overall thickness of member, in.) from the face of support is closer to end of a member than the transfer length** of the prestressing tendons.	X	f_{pcr}	
Web width, or diameter of circular section, in.	X	b_w	
Distance from extreme compression fiber to centroid of prestressed reinforcement of 0.8h (h = overall member thickness, in.) whichever is greater.	X	$\bar{d}$	
Shear force corresponding to dead load (DL) and live load (LL) that results in a principal tensile stress of $4\sqrt{f'_c}$ at centroidal axis is in the flange. In composite members, principal tensile stress shall be computed using the cross section that resists live load.	X	V_{pt}	
Shear force, V_{pt} determined considering reduced prestress, f_{pcr} .	X	V_{ptr}	
Vertical component of effective prestress force at section.	X	V_p	

(Continued)

* Prestress force may be assumed to vary linearly from zero at the end of tendon to a maximum at a distance from end of tendon equal to transfer length.

** Transfer length is assumed to be 50 diameters for strand and 100 diameters for wire. Transfer length for tendons other than wire or strand is not provided.

DLT 11.4(a) V_{cw} and V_{cwr}		1	2
C1	Section at a distance h/2 from the face of support closer to end of member than the transfer length of the prestressing tendons?	Y	N
A1	$V_{cw} = (3.5\sqrt{f'_c} + 0.3\, f_{pc})b_w \bar{d} + V_p$ <u>or</u> $V_{cw} = V_{pt}$		X
A2	$V_{cwr} = (3.5\sqrt{f'_c} + 0.3 f_{pcr})b_w \bar{d} + V_p$ <u>or</u> $V_{cwr} = V_{ptr}$	X	
A3	DLT 11.4(b)	X	X

Comments:

1) DLT 11.4(a) covers Sections 11.4.2.2, 11.4.2.3, and 11.4.3.

2) The Code does not specifically state at which section f_{pcr} is calculated. Assumed here to be h/2 from end.

Datum 11.4(b)	Source	Label	Number
Effective prestress	X		
Tensile strength of flexural reinforcement.	X		
Specified compressive strength of concrete, psi.	X	f'_c	
Web width, or diameter of circular section, in.	X	bw	
Distance from extreme compression fiber to centroid of longitudinal tension reinforcement, but need not be less than 0.80 h (h = overall member thickness, in.) for prestressed members, in. (For circular sections, d need not be less than the distance from extreme compression fiber to centroid of reinforcement in opposite half of member.)	X	d	
Factored shear force at section occurring simultaneously with factored moment at section considered.	X	V_u*	
Factored moment occurring simultaneously with factored shear at section considered.	X	M_u*	
Distance from extreme compression fiber to centroid of prestressed reinforcement.	X	d'	
Nominal shear strength provided by concrete when diagonal cracking results from excessive principal tensile stress in web.	DLT 11.4(a)	V_{cw}	
Nominal shear strength provided by concrete when diagonal cracking results from excessive principal tensile stress in web computed considering reduced prestress.	DLT 11.4(a)	V_{cwr}	
Maximum factored moment at section due to externally applied loads.	X	M_{max}**	
Factored shear force at sections due to externally applied loads occurring simultaneously with M_{max}.	X	V_i**	

(Continued)

* $V_u d'/M_u \leq 1$. M_u is factored moment occurring simultaneously with V_u at section considered.

** Values of M_{max} and V_i shall be computed from the load combination causing maximum moment to occur at the section.

Datum 11.4(b) - Continued	Source	Label	Number
Moment of inertia of section resisting externally applied factored loads.	X	I	
Distance from entroidal axis or gross section, neglecting reinforcement, to extreme fiber in tension.	X	Y_t	
Compressive stress in concrete due to effective prestress forces only (after allowance for all prestress loss) at extreme fiber of section where tensile stress is caused by externally applied loads, psi.	X	f_{pe}	
Stress due to unfactored dead load, at extreme fiber of section where tensile stress is caused by externally applied loads, psi.	X	f_d	
Distance from extreme compression fiber to centroid of prestressed reinforcement or 0.8h (h = overall member thickness, in.) whichever is greater.	X	$\bar{d}$	

(Continued)

DLT 11.4(b) V_c		1	2	3
C1	Effective prestress - 40% of the tensile strength of flexural reinforcement?	Y	Y	N
C2	Detailed calculation to be made?	Y	N	I
A1	$2\sqrt{f'_c}\, b_w d \leq V_c = (0.6\sqrt{f'_c} + 700 \frac{V_u d'}{M_u}) b_w d$ $\leq \min\ 5\sqrt{f'_c}\, b_w d,\ V_{cwr}\ \underline{or}\ 5\sqrt{f'_c}\, b_w d$		X	
A2	$V_c = \min\ V_{ci},\ V_{cw}\ \underline{or}\ V_{cwr}$ $V_{ci} = \max\ 0.6\sqrt{f'_c}\, b_w d + V_d + \frac{V_i M_{cr}}{M_{max}},\ (1.7\sqrt{f'_c}\, b_w d$ $M_{cr} = (I/Y_t)(6\sqrt{f'_c} + f_{pe} - f_d)$	X		
A3	Section 11.5	X	X	X

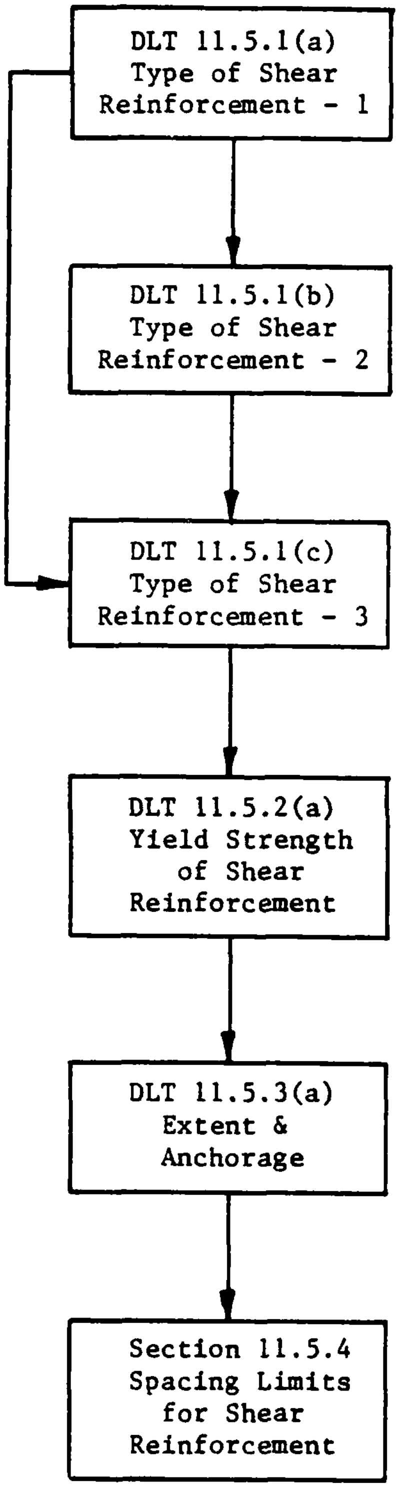
Comments:

1) DLT 11.4(b) covers Section 11.4.1 and part of 11.4.2 and 11.4.2.1.

2) It is assumed here that V_{cwr} based on reduced prestress, f_{pcr}, exists only if the response to C1 in DLT 11.4(a) is yes (Y).

(Sheet 3 of 3)

Section 11.5 Map



Section 11.5 Shear Strength Provided by Shear Reinforcement

Datum 11.5.1(a)	Source	Label	Number
If member is prestressed.	X		

DLT 11.5.1(a)	Type of Shear Reinforcement - 1	1	2
C1	Member prestressed?	Y	N
A1	DLT 11.5.1(b)	X	
A2	DLT 11.5.1(c)		X

Comment:

1) DLT 11.5.1(a) is a switching DLT.

Datum 11.5.1(b)	Source	Label	Number
Type of shear reinforcement provided.	X		

DLT 11.5.1(b) Type of Shear Reinforcement - 2		1	2	3	
C1	Type = stirrups perpendicular to axis of member?	Y	N	N	ELSE
C2	Welded wire fabric with wires located perpendicular to axis of member?	N	Y	N	
A1	Provisions - satisfied	X	X		
A2	No provision			X	
A3	DLT 11.5.1(c)	X	X	X	
A4	Logical Error				X

Comments:

1) DLT 11.5.1(b) checks the requirements of Section 11.5.1.1 for prestressed members.

2) It is assumed here and in DLT 11.5.1(c) that the types of shear reinforcement listed in the Code are the only acceptable forms.

3) The combination of stirrups and welded wire fabric is assumed to be disallowed by implication. This is implied only because the combination of bent longitudinal reinforcement and stirrups is presented in the Code.

Datum 11.5.1(c)	Source	Label	Number
Type of shear reinforcement provided.	X		

	DLT 11.5.1(c) Type of Shear Reinforcement - 3	1	2	3	4	5	6	
C1	Type = stirrups perpendicular to axis of member?	N	N	Y	N	N	N	E L S E
C2	Type = welded wire fabric with wires located perpendicular to axis of member?	Y	N	N	N	N	N	
C3	Type = stirrups making an angle $\geq 45^\circ$ with longitudinal tension reinforcement?	N	N	I	Y	N	N	
C4	Type = longitudinal reinforcement with bent portion making an angle $\geq 30^\circ$ with the longitudinal tension reinforcement?	N	N	I	I	Y	N	
C5	Type = spirals?	N	Y	N	N	N	N	
A1	Provisions = satisfied	X	X	X	X	X		
A2	Provisions $\neq$ satisifed						X	
A3	DLT 11.5.2(a)	X	X	X	X	X	X	
A4	Logical Error							X

Comments:

1) DLT 11.5.1(c) covers Section 11.5.1 for nonprestressed members.

2) It is assumed here that welded wire fabric and spirals cannot be combined with each other nor with other types of shear reinforcement.

3) It is assumed here that all other types (i.e., C1, C3, and C4) may be mixed.

Datum 11.5.2(a)	Source	Label	Number
Design yield strength of shear reinforcement.	X	f_{yd}	

DLT 11.5.2(a) Yield Strength of Shear Reinforcement		1	2
C1	$f_{yd} \leq 60000$ psi?	Y	N
A1	Provisions = satisfied	X	
A2	Provisions ≠ satisfied		X
A3	DLT 11.5.3(a)	X	X

Comment: 1) DLT 11.5.2(a) covers Section 11.5.2.

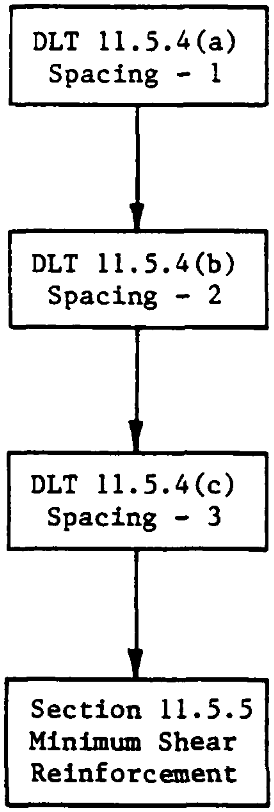
Datum 11.5.3(a)	Source	Label	Number
Extent of shear reinforcement from extreme compression fiber.	X		
If shear reinforcement is anchored at both ends according to Section 12.14 to develop the design yield strength of the reinforcement.	X		
Distance from extreme compression fiber to centroid of longitudinal tension reinforcement, but need not be less than 0.80h for prestressed members, in. (For circular sections, d need not be less than the distance from extreme compression fiber to centroid of tension reinforcement in opposite half of member.)	X	d	

DLT 11.5.3(a) Extent & Anchorage		1	2	3
C1	Extent of shear reinforcement from extreme compression fiber = d?	Y	Y	N
C2	Anchored at both ends according to Section 12.14 to develop the design yield strength of the reinforcement?	Y	N	I
A1	Provisions = satisfied	X		
A2	Provisions ≠ satisfied		X	X
A3	DLT 11.5.4(a)	X	X	X

Comments: 1) DLT 11.5.3(a) covers Section 11.5.3.

2) It is not clear if the phrase in C2 and Section 11.5.3 "...to develop the design yield strength of reinforcement." is meant to be an additional requirement or whether the provisions of Section 12.14, if satisfied, will provide anchorage which will develop the design yield strength.

Section 11.5.4 Map



Section 11.5.4 Spacing Limits for Shear Reinforcement

Datum 11.5.4(a)	Source	Label	Number
Orientation of shear reinforcement with respect to axis of member.	X		
If member is prestressed.			
Distance from extreme compression fiber to centroid of longitudinal tension reinforcement, but need not be less than 0.80h for prestressed members, in. (For circular sections, d need not be less than the distance from extreme compression fiber to centroid of tension reinforcement in opposite half of member.)	X	d	
Overall thickness of member, in.	X	h	

DLT 11.5.4(a)	Spacing - 1	1	2	3
C1*	Shear reinforcement placed perpendicular to axis of member?	Y	Y	N
C2	Member prestressed?	Y	N	I
A1	Maximum spacing, $s_m = d/2$		X	
A2	Maximum spacing, $s_m = \min[3/4\ h,\ 24]$	X		
A3	Maximum spacing, s_m = value such that every 45° line extending from middepth of member, d/2 , to longitudinal tension reinforcement shall be crossed by at least one line of shear reinforcement.			X
A4	DLT 11.5.4(b)	X	X	X

Comment:

1) DLT 11.5.4(a) covers Sections 11.5.4.1 and 11.5.4.2.

* Shear reinforcement considered which is not perpendicular to axis of member is bent longitudinal reinforcement or inclined stirrups.

Datum 11.5.4(b)	Source	Label	Number
Nominal shear strength provided by shear reinforcement.	X	V_s	
Square root of specified compressive strength of concrete, psi.	X	$\sqrt{f'_c}$	
Web width, or diameter of circular section, in.	X	b_w	
Distance from extreme compression fiber to centroid of longitudinal tension reinforcement, but need not be less than 0.80h for prestressed members, in. (For circular sections, d need not be less than the distance from extreme compression fiber to centroid of tension reinforcement in opposite half of member.)	X	d	
Maximum spacing of shear reinforcement.	DLT 11.5.4(a)	s_m	

DLT 11.5.4(b)	Spacing - 2	1	2
C1	$V_s \leq 4\sqrt{f'_c}\, b_w d$?	Y	N
A1	Maximum spacing, $s_m = s_m/2$		X
A2	Maximum spacing, $s_m = s_m$	X	
A3	DLT 11.5.4(c)	X	X

Comment:

1) DLT 11.5.4(b) covers Section 11.5.4.3.

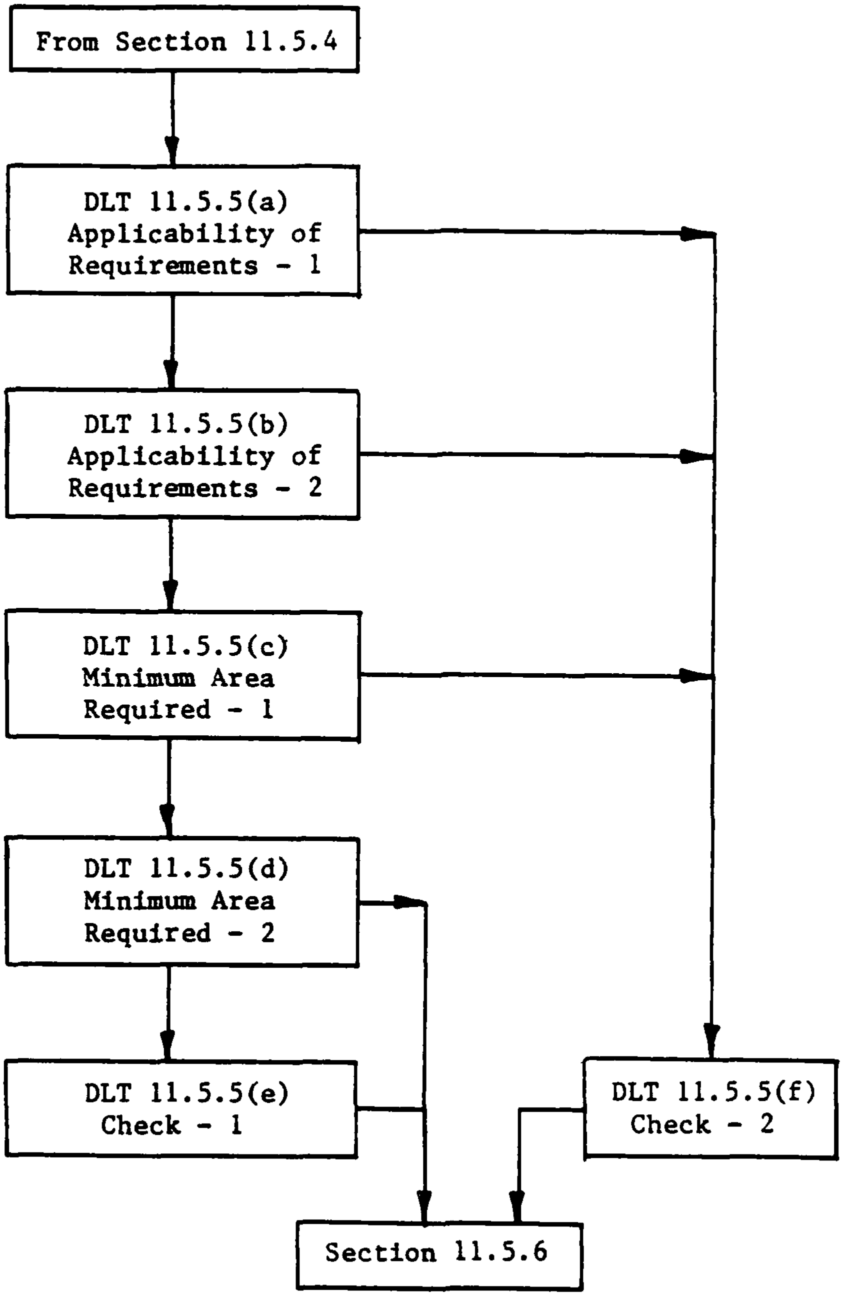
Datum 11.5.4(c)	Source	Label	Number
Actual spacing of shear reinforcement, in.	X	s	
Maximum allowable spacing of shear reinforcement, in.	DLT 11.5.4(b)		

DLT 11.5.4(c) Spacing - 3		1	2
C1	$s \le s_m$?	Y	N
A1	Provisions = satisfied	X	
A2	Provisions ≠ satisfied		X
A3	Section 11.5.5	X	X

Comment:

1) DLT 11.5.4(c) checks the provisions of Section 11.5.4.

Section 11.5.5 Map



Section 11.5.5 Minimum Shear Reinforcement

Datum 11.5.5(a)	Source	Label	Number
Member type.	X		
Flange thickness and web width of beam member.	X		
Factored shear force at section.	X	V_u	
Nominal shear strength provided by concrete.	Section 11.3 or 11.4	V_c	
Strength reduction factor.	X	ϕ	
If shear reinforcement is required by analysis.	X		

DLT 11.5.5(a) Applicability - 1		1	2	3	4	5	6
C1	Member type = slab or footing, concrete joist construction defined by Section 8.11, or beams with a total depth ≤ maximum [10 in., 2½ flange thickness, ½ web width]?	Y	Y	Y	N	N	N
C2	$V_u \geq \frac{1}{2} \phi V_c$?	I	Y	N	Y	N	N
C3	Shear reinforcement required by analysis?	Y	N	N	I	Y	N
A1	DLT 11.5.5(b)	X			X	X	
A2	No minimum shear reinforcement required: $A_{vm} = 0$. DLT 11.5.5(f)		X				
A3	No shear reinforcement required: $A_{vm} = 0$ DLT 11.5.5(f)			X			X

Comments:

1) DLT 11.5.5(a) covers Section 11.5.5.1 and part of Section 11.5.5.3.

2) It is assumed here that requirement C3 found in Section 11.5.5.3 overrides the exclusions of Section 11.5.5.1.

3) Assumed that if $V_u < \frac{1}{2}\phi V_c$ and that shear reinforcement is not required by analysis, then no shear reinforcement is required. See Section 11.5.6.1.

4) Decision Rule 2 reveals that no minimum could be required, but shear reinforcement still could be required per Section 11.5.6.1.

Datum 11.5.5(b)	Source	Label	Number
If it can be shown by test that required ultimate flexural and shear strength can be developed when shear reinforcement is omitted.	X		

DLT 11.5.5(b) Applicability - 2		1	2
C1	Shown by test that required ultimate flexural and shear strength can be developed when shear reinforcement is omitted?	Y	N
A1	No minimum shear reinforcement required, $A_{vm} = 0$, DLT 11.5.5(f)	X	
A2	DLT 11.5.5(c)		X

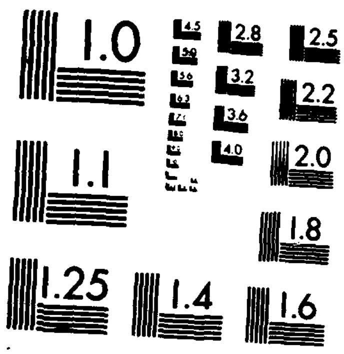
Comments: 1) DLT 11.5.5(b) covers Section 11.5.5.2.

2) It is assumed here that the exception permitted in Section 11.5.5.2 overrides the requirements of Section 11.5.5.1 and of the first sentence of Section 11.5.5.3.

Datum 11.5.5(c)	Source	Label	Number
Factored torsional moment.	X	T_u	
Strength reduction factor.	X	ϕ	
Square root of specified compressive strength of concrete, psi.	X	$\sqrt{f'_c}$	
Torsional section properties (see Section 11.6)	X	$\sum x^2y$	
If the member is prestressed with prestress force $\geq$ tensile strength of flexural reinforcement.	X		
Web width, or diameter of circular section, in.	X	b_w	
Spacing of shear or torsional reinforcement in direction parallel to longitudinal reinforcement, in.	X	s	
Specified yield strength of nonprestressed reinforcement, psi.	X	f_y	
Area of prestressed reinforcement in tension zone, sq in.	X	A_{ps}	
Specified tensile strength of prestressing tendons, psi.	X	f_{pu}	
Distance from extreme compression fiber to centroid of longitudinal tension reinforcement, but need not be less than 0.80h for prestressed members, in. (For circular sections, d need not be less than the distance from extreme compression fiber to centroid of tension reinforcement in opposite half of member.)	X	d	

(Continued)

AD-A173 663 COMPUTER-AIDED STRUCTURAL ENGINEERING (CASE) PROJECT: 5/6
DECISION LOGIC TABL (U) ATKINSON-NOLAND & ASSOCIATES
INC BOULDER CO J L NOLAND JUL 86 ATC-TR-86-5-VOL-1
UNCLASSIFIED DACW39-82-M-3741 F/G 9/2 NL



'CROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

DLT 11.5.5(c) Minimum Area of Shear Reinforcement - 1		1	2	3
C1	$T_u \leq \phi(0.5\sqrt{f'_c} \sum x^2 y)$?	Y	Y	N
C2	Prestressed member with prestress force $\geq$ 40% tensile strength of flexural reinforcement?	Y	N	I
A1	$A_{vm} = 50\ b_w s/f_y$		X	
A2	$A_{vm} = \min \left[\frac{50\ b_w s}{f_y}, \frac{A_{ps}}{80} \frac{f_{pu}}{f_y} \frac{s}{d} \sqrt{\frac{d}{b_w}} \right]$	X		
A3	DLT 11.5.5(d)			X
A4	DLT 11.5.5(f)	X	X	

Comment:

1) DLT 11.5.5(c) covers Sections 11.5.5.3 and 11.5.5.4.

Datum 11.5.5(d)	Source	Label	Number
Type of shear reinforcement.	X		
Area of two legs of closed stirrup within a distance s, sq in.	X	A_v	
Area of one leg of a closed stirrup resisting torsion within a distance s, sq in.	X	A_t	
Web width, or diameter of a circular section, in.	X	b_w	
Spacing of shear or torsion reinforcement in a direction parallel to longitudinal reinforcement, in.	X	s	
Specified yield strength of non-prestressed reinforcement, psi.	X	f_y	

DLT 11.5.5(d)	Minimum Area of Shear Reinforcement - 2	1	2
C1	Shear reinforcement = closed stirrups?	Y	N
A1	$(A_v + 2A_t)_{min} = 50\ b_w s/f_y$	X	
A2	No Provision, Section 11.5.6		X
A3	DLT 11.5.5(e)	X	

Comments: 1) DLT 11.5.5(d) covers Section 11.5.5.5.

2) The definition of A_v in the Datum Table includes the specific description presented in the Commentary.

3) Section 11.6.7.3 states that "Torsion reinforcement shall consist of closed stirrups, ties, or spirals, combined with longitudinal bars." Minimum area requirements apparently apply only to closed stirrups per Section 11.5.5.5.

Datum 11.5.5(e)	Source	Label	Number
Minimum area of closed stirrups.	DLT 11.5.5(d)	$(A_v+2A_t)_{min.}$	
Area of closed stirrups used.	X		

DLT 11.5.5(e) Check - 1		1	2
C1	Area of closed stirrups used $\geq (A_v + 2A_t)_{min.}$?	Y	N
A1	Provisions = satisfied	X	
A2	Provisions $\neq$ satisfied		X
A3	Section 11.5.6	X	X

Comment:

1) DLT 11.5.5(e) partially covers Section 11.5.5.5.

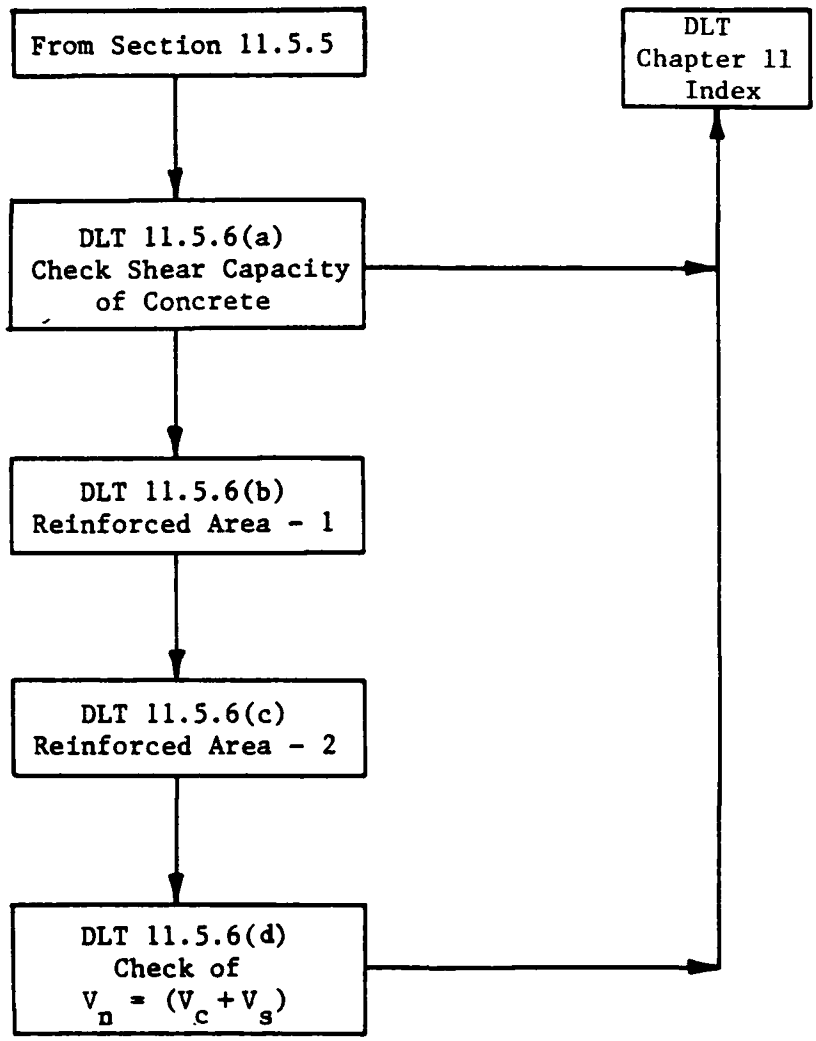
Datum 11.5.5(f)	Source	Label	Number
Minimum area of shear reinforcement.	DLT 11.5.5(c)	A_{vm}	
Area of shear reinforcement used.	X		

DLT 11.5.5(f) Check - 2		1	2
C1	Area of shear reinforcement used $\geq A_{vm}$?	Y	N
A1	Provisions = satisfied	X	
A2	Provisions $\neq$ satisfied		X
A3	Section 11.5.6	X	X

Comment:

1) DLT 11.5.5(f) partially covers Sections 11.5.5.3 and 11.5.5.4.

Section 11.5.6 Map



Section 11.5.6 Design of Shear Reinforcement

Datum 11.5.6(a)	Source	Label	Number
Factored shear force at section.	X	V_u	
Strength reduction factor.	X	ϕ	
Nominal shear strength provided by concrete.	Section 11.3 or 11.4	V_c	

DLT 11.5.6(a)	Check Shear Capacity of Concrete	1	2
C1	$V_u \leq \phi V_c$?	Y	N
A1	Provisions = satisfied	X	
A2	DLT 11.5.6(b)		X
A3	DLT Ch 11	X	

Comment:

1) DLT 11.5.6(a) covers Section 11.5.6.1.

Datum 11.5.6(b)	Source	Label	Number
Type of shear reinforcement.	X		
Nominal shear strength provided by shear reinforcement.	X	V_{si}	
Area of shear reinforcement within a distance s, or area of shear reinforcement perpendicular to flexural tension reinforcement within a distance s for deep flexural members, sq in.	X	A_{vi}	
Design yield strength of shear reinforcement.	X	f_{yd}	
Distance from extreme compression fiber to centroid of longitudinal tension reinforcement, but need not be less than 0.80h for prestressed members, in. (For circular sections, d need not be less than the distance from extreme compression fiber to centroid of tension reinforcement in opposite half of member.)	X	d	
Spacing of shear or torsion reinforcement in direction parallel to longitudinal reinforcement, in.	X	s	
Square root of specified compressive strength of concrete, psi.	X	$\sqrt{f'_c}$	
Web width or diameter of circular section, in.	X	b_w	
Angle between inclined stirrups and longitudinal axis of member.	X	α	

(Continued)

DLT 11.5.6(b) Reinforced Area - 1		1	2	3	4
C1	Shear reinforcement perpendicular to the axis of member?	Y	Y	N	N
C2	Shear reinforcement = inclined stirrups?	Y	N	Y	N
A1	$V_{s1} = \min\left[\frac{A_{v1} f_y d}{s}, 8\sqrt{f'_c}\, b_w d\right]$	X	X		
A2	$V_{s2} = \min\left[\left(A_{v2} f_y (\sin\alpha + \cos\alpha)\right) d/s, 8\sqrt{f'_c}\, b_w d\right]$	X		X	
A5	No provision, $V_{s3} = 0$				X
A9	DLT 11.5.6(c)	X	X	X	X

Comment:

1) DLT 11.5.6(b) covers Sections 11.5.6.2, 11.5.6.3, and 11.5.6.8.

Datum 11.5.6(c)	Source	Label	Number
Type of shear reinforcement.	X		
Nominal shear strength provided by shear reinforcement.	X	V_{si}	
Area of shear reinforcement within a distance s, or area of shear reinforcement perpendicular to flexural tension reinforcement within a distance s for deep flexural members, sq in.	X	A_{vi}	
Design yield strength of shear reinforcement.	X	f_{yd}	
Distance from extreme compression fiber to centroid of longitudinal tension reinforcement, but need not be less than 0.80h for prestressed members, in. (For circular sections, d need not be less than the distance from extreme compression fiber to centroid of tension reinforcement in opposite half of member.)	X	d	
Spacing of shear or torsion reinforcement in direction parallel to longitudinal reinforcement, in.	X	s	
Square root of specified compressive strength of concrete, psi.	X	$\sqrt{f'_c}$	
Web width or diameter of circular section, in.	X	b_w	
Angle between inclined stirrups and longitudinal axis of member.	X	α	

(Continued)

DLT 11.5.6(c) Reinforced Area - 2		1	2	3	
C3	Shear reinforcement = single bar or a single group of parallel bars all bent up at the same distance from the support?	Y	N	N	E L
C4	Shear reinforcement = series of parallel bent-up bars or groups of parallel bent-up bars at different distances from the support?	N	Y	N	S E
A3*	$V_{s4} = \min \left[A_{v4} f_y \sin\alpha,\ 3\sqrt{f'_c}\ b_w d \right]$	X			
A4*	$V_{s5} = \min \left[\left(A_v f_y (\sin\alpha + \cos\alpha) d \right)/s,\ 8\sqrt{f'_c}\ b_w d \right]$		X		
A5	No provision $V_{s6} = 0$			X	
A6	$V_s = \sum_{i=1}^{6} V_{si}$	X	X	X	
A7	DLT 11.5.6(d)	X	X	X	
A8	Logical Error				X

Comments:

1) DLT 11.5.6(c) covers Sections 11.5.6.4, 11.5.6.5, 11.5.6.7, and 11.5.6.8.

2) Section 11.5.6.6 is covered by the footnote.

3) The constraint of Section 11.5.6.8 is applied to Eqs (11.17) and (11.18) only.

---

* Only the center three-fourths of the inclined portion of any longitudinal bent bar shall be considered effective for shear reinforcement.

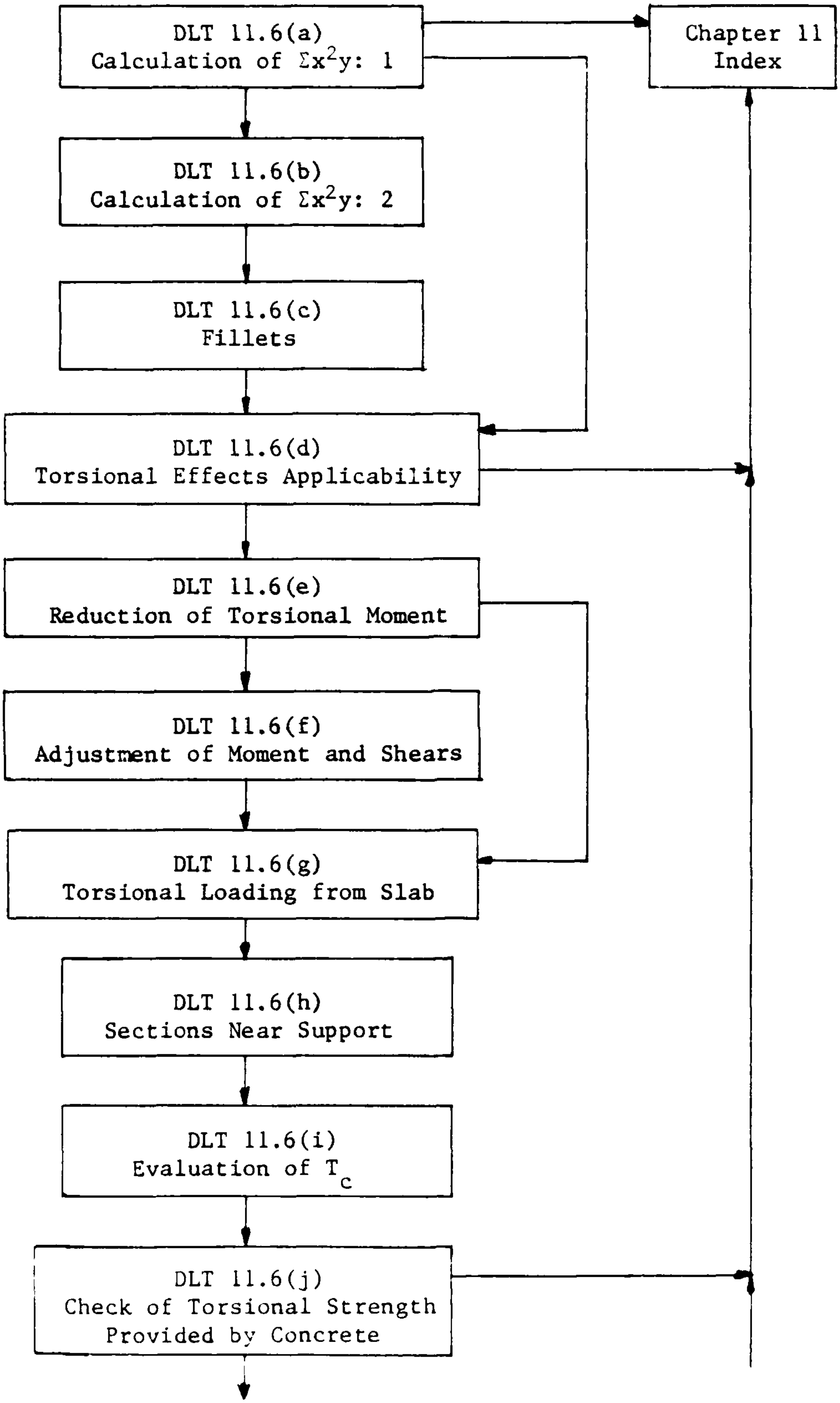
Datum 11.5.6(d)	Source	Label	Number
Factored shear force at section.	X	V_u	
Strength reduction factor.	X	ϕ	
Nominal shear strength provided by concrete.	Section 11.3 or 11.4	V_c	
Nominal shear strength provided by reinforcement.	DLT 11.5.6(b)	V_s	

DLT 11.5.6(d) Check of $V_n = (V_c + V_s)$		1	2
C1	$V_u \leq \phi(V_c + V_s)$?	Y	N
A1	Provisions = satisfied	X	
A2	Provisions $\neq$ satisfied		X
A3	DLT Chapter 11	X	X

Comment:

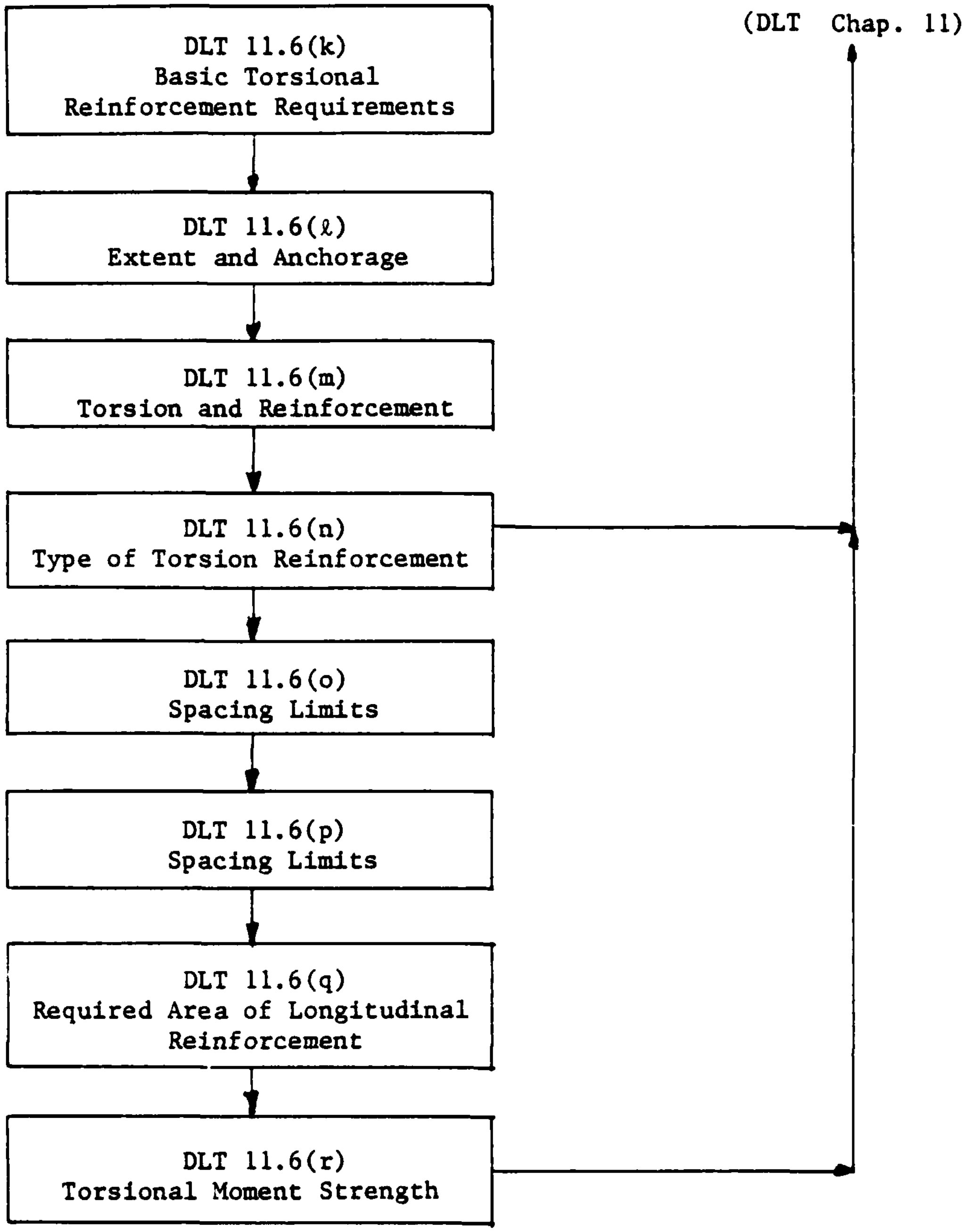
1) DLT 11.5.6(d) covers Section 11.1.1.

Section 11.6 Map



(Continued)

Section 11.6 Map (Concluded)



Section 11.6 Combined Shear and Torsion Strength for Nonprestressed Members with Rectangular or Flanged Sections

Datum 11.6(a)	Source	Label	Number
Member configuration.	X		

DLT 11.6(a)	Calculation of $\sum x^2y$ - 1	1	2	3	
C1	Member with rectangular or flanged section?	Y	N	N	ELSE
C2	Rectangular box section?	N	Y	N	
A1*	$\sum x^2y$ = sum of x^2y for component rectangles of section	X			
A2	DLT 11.6(b)		X		
A3	No provision, DLT Chapter 11			X	
A4	DLT 11.6(d)	X			
A5	Logical Error				X

Comment:

1) DLT 11.6(a) covers 11.6.1.1.

* Overhanging flange width used in design shall not exceed three times the flange thickness.

Datum 11.6(b)	Source	Label	Number
Shorter overall dimension of rectangular part of cross section.	X	x	
Larger overall dimension of rectangular part of cross section.	X	y	
Wall thickness of box section.	X	h_w	

DLT 11.6(b) Calculation of $\sum x^2y$ - 2		1	2	3	
C1	$h_w \geq x/4$?	Y	N	N	ELSE
C2	$x/10 \leq h_w < x/4$?	N	Y	N	
A1	$\sum x^2y$ = (x^2y of box considered as a solid section.)	X			
A2	$\sum x^2y = \left(\frac{4h_w}{x}\right)$ (x^2y of box considered as a solid section.)		X		
A3	$\sum x^2y$ = sum of x^2y of component rectangles and stiffness of the wall shall be considered.			X	
A4	DLT 11.6(c)	X	X	X	
A5	Logical Error				X

Comments: 1) DLT 11.6(b) partially covers Section 11.6.1.2.

2) In this DLT, C2 provides for the possibility that h_w equals $x/10$. The Code, as written, only considers values of h_w less than or greater than $x/10$, and not values of $h_w = 10$. The lower limit in C2 above has been written to admit values of $h_w = 10$.

3) It is assumed in A3 above, that if a box section cannot be treated as a solid section, $\sum x^2y$ is based on x^2y of the component rectangles. This is not explicitly stated in the Code.

Datum 11.6(c)	Source	Label	Number
If fillets are provided at all interior corners.	X		

DLT 11.6(c) Fillets		1	2
C1	Fillets provided at interior corners of box section?	Y	N
A1	Provisions = satisfied	X	
A2	Provisions ≠ satisfied		X
A3	DLT 11.6(d)	X	X

Comment:

1) DLT 11.6(c) partially covers Section 11.6.1.2.

Datum 11.6(d)	Source	Label	Number
Factored torsional moment of section.	X	T_u	
Strength reduction factor.	X	ϕ	
Square root of specified compressive strength of concrete, psi.	X	$\sqrt{f'_c}$	
Torsional section properties.	DLT 11.6(a) DLT 11.6(b)		

DLT 11.6(d) Torsional Effects Applicability		1	2
C1	$T_u > \phi\ (0.5\ \sqrt{f'_c} \sum x^2y)$?	Y	N
A1	DLT 11.6(e)	X	
A2	Torsional effects may be neglected, DLT Chapter 11		X

Comment:

1) DLT 11.6(d) covers Section 11.6.1.

Datum 11.6(e)	Source	Label	Number
Factored torsional moment at section.	X	T_u	
If maximum factored torsional moment at section was reduced to $\phi(4\sqrt{f'_c}\sum x^2y/3)$.	X		
If structure is statically indeterminant where reduction of torsional moment in a member can occur due to redistribution of internal forces.	X		

DLT 11.6(e) Reduction of Torsional Moment		1	2	3	4
C1	Structure statically indeterminant where reduction of torsional moment in a member can occur due to redistribution of internal forces?	Y	Y	N	N
C2	Maximum T_u reduced to $\phi\left(4\sqrt{f'_c}\,\frac{\Sigma x^2y}{3}\right)$?	Y	N	Y	N
A1	Provisions = satisfied	X	X		
A2	Provisions ≠ satisfied			X	
A3	DLT 11.6(f)	X			
A4	DLT 11.6(g)		X	X	X

Comments: 1) DLT 11.6(e) covers Section 11.6.3.

Datum 11.6(f)	Source	Label	Number
If correspondingly adjusted moments and shears in adjoining members are used in design.	X		

DLT 11.6(f)	Adjustment of Moment and Shears	1	2
C1	Correspondingly adjusted moments and shears in adjoining members used in design?	Y	N
A1	Provision = satisfied	X	
A2	Provision ≠ satisfied		X
A3	DLT 11.6(g)	X	X

Comment:

1) DLT 11.6(f) covers Section 11.6.3.1.

Datum 11.6(g)	Source	Label	Number
Source of torsional loading on member.	X		
If exact analysis of torsional loading was done.	X		
Distribution of torsional loading on member.	X		

DLT 11.6(g)	Torsional Loading from Slab	1	2	3	4
C1	Source of torsional loading on member = slab?	Y	Y	Y	N
C2	Exact analysis of torsional loading done?	Y	N	N	I
C3	Distribution of torsional loading on member = uniform?	Y	Y	N	I
A1	Provision = satisfied	X	X		
A2	Provision ≠ satisfied			X	
A3	No provision				X
A4	DLT 11.6(h)	X	X	X	X

Comment:

1) DLT 11.6(g) covers Section 11.6.3.2.

Datum 11.6(h)	Source	Label	Number
Factored torsional moment at the section less than distance d from face of the support.	X	$\overline{T}_u$	
Factored torsional moment at distance d from the face of the support.	X	T_{ud}	

DLT 11.6(h)	Sections Near Support	1	2
C1	$\overline{T}_u = T_{ud}$?	Y	N
A1	Provisions = satisfied	X	X
A2	DLT 11.6(i)	X	X

Comment:

1) DLT 11.6(h) covers Section 11.6.4.

Datum 11.6(i)	Source	Label	Number
Square root of specified compressive strength of concrete.	X	$\sqrt{f'_c}$	
Factored torsional moment at section.	X	T_u	
Torsional section properties.	DLT 11.6(a) DLT 11.6(b)	$\sum x^2y$	
Factor relating shear and torsional stress properties.		C_t *	
Web width, or diameter of circular section, in.	X	b_w	
Distance from extreme compression fiber to centroid of longitudinal tension reinforcement, but need not be less than 0.8h for prestressed members, in. (For circular sections, d need not be less than the distance from extreme compression fiber to centroid of tension reinforcement in opposite half of member.)	X	d	
Factored shear force at section.	X	V_u	
Factored axial load normal to cross-section occurring simultaneously with V_u; to be taken as positive for compression, negative for tension and to include effects of tension due to creep and shrinkage.	X	N_u	
Gross area of section, sq in.	X	A_g	

Continued

* $C_t = b_w d / \Sigma x^2 y$.

DLT 11.6(i) Evaluation of T_c		1	2
C1	Member subjected to significant axial tension?	Y	N
A1	$T_c = \left(1 + \frac{N_u}{500\ A_g}\right)\left[\frac{0.8\sqrt{f'_c}\sum x^2y}{\sqrt{1 + \left(\frac{0.4\ V_u}{C_t T_u}\right)^2}}\right]$	X	
A2	$T_c = \left[\frac{0.8\sqrt{f'_c}\sum x^2y}{\sqrt{1 + \left(\frac{0.4\ V_u}{C_t T_u}\right)^2}}\right]$		X
A3	DLT 11.6(j)	X	X

Comments:

1) DLT 11.6(i) covers Section 11.6.6.
2) Modification of V_c given by Eq (11.5) is done in DLT 11.3(e).
3) The premise of this DLT is that a detailed calculation (A1 above) will be made if axial tension is significant.

Datum 11.6(j)	Source	Label	Number
Factored torsional moment of section.	X	T_u	
Strength reduction factor.	X	ϕ	
Nominal torsional moment strength provided by concrete.	DLT 11.6.(i)	T_c	
If torsional reinforcement is provided.	X		

DLT 11.6(j) Check of Torsional Strength Provided by Concrete		1	2	3
C1	$T_u > \phi T_c$?	Y	Y	N
C2	Torsional reinforcement provided?	Y	N	I
A1	Provision = satisfied	X		X
A2	Provision ≠ satisfied		X	
A3	DLT 11.6(k)	X		
A4	DLT Chapter 11		X	X

Comment:

1) DLT 11.6(j) partially covers Section 11.6.7.1 and partially covers Section 11.6.9.1.

Datum 11.6(k)	Source	Label	Number
If torsional reinforcement provided is in addition to reinforcement required to resist shear, flexure and axial forces?	X		
Design yield strength of torsional reinforcement.	X	f_{yt}	
Distance from extreme compression fiber to centroid of longitudinal tension reinforcement, but need not be less than 0.8h for prestressed members, in. (For circular sections, d need not be less than the distance from extreme compression fiber to centroid of tension reinforcement in opposite half of member.)	X	d	
Width of compression face of member, in.	X	b	
Distance beyond point theoretically required in which torsional reinforcement is provided.	X		

DLT 11.6(k)	Basic Torsional Reinforcement Requirements	1	2	3	4	
C1	Torsional reinforcement provided is in addition to reinforcement required to resist shear, flexure and axial forces?	Y	Y	Y	N	E
						L
C2	$f_{yt} \leq 60000$ psi?	Y	Y	N	I	
						S
C3	Torsion reinforcement provided a distance $\geq(b_t+d)$ beyond the point theoretically required?	Y	N	I	I	E
A1	Provisions = satisfied	X				
A2	Provisions ≠ satisfied		X	X	X	
A3	DLT 11.6(ℓ)	X	X	X	X	
A4	Logical Error					X

Comment:

1) DLT 11.6(k) covers Sections 11.6.7.1, 11.6.7.4, and 11.6.7.6.

Datum 11.6(ℓ)	Source	Label	Number
Extent of shear reinforcement from extreme compression fiber.	X		
If anchored at both ends according to Section 12.14?	Section 12.14		
Distance from extreme compression fiber to centroid of longitudinal tension reinforcement, but need not be less than 0.80h for prestressed members, in. (For circular sections, d need not be less than the distance from extreme compression fiber to centroid of tension reinforcement in opposite half of member.)	X	d	

DLT 11.6(ℓ)	Extent and Anchorage	1	2	3
C1	Torsional reinforcement extends a distance = d from extreme compression fiber?	Y	Y	N
C2	Anchored at both ends according to Section 12.14 to develop the design yield strength of the reinforcement?	Y	N	I
A1	Provisions = satisfied	X		
A2	Provisions ≠ satisfied		X	X
A3	DLT 11.6(m)	X	X	X

Comments: 1) DLT 11.6(ℓ) covers Section 11.6.7.5.

Datum 11.6(m)	Source	Label	Number
If torsion reinforcement is combined with that required for other forces.	X		
Area of reinforcement required for shear.	Section 11.5.5	A_{vm}	
Area of closed stirrup used for torsion.	X	A_t	
Area of longitudinal bars used for flexure.	X	A_s	
Area of longitudinal bars required for torsion.	DLT 11.6(n)	A_ℓ	
Spacing of reinforcement required for shear.	Section 11.5.4		
Spacing of reinforcement required for torsion.	DLT 11.6(o) 11.6(p)		

DLT 11.6(m)	Torsion and Reinforcement	1	2	3	4
C1	Torsion reinforcement combined with that required for other forces?	Y	Y	Y	N
C2	Area furnished = sum of individually required areas?	Y	Y	N	I
C3	Spacing $\leq$ min [spacing required for shear, spacing required for torsion]?	Y	N	I	I
A1	Provisions = satisfied	X			
A2	Provisions $\neq$ satisfied		X	X	
A3	DLT 11.6(n)	X	X	X	X

Comments: 1) DLT 11.6(m) covers Section 11.6.7.2 except for placement requirements which, per Sections 7.5 and 7.6, appear to be general and not unique to torsion, flexure or shear reinforcement.

2) The Code does not provide direct requirements for area of closed ties for torsion nor of longitudinal bars for flexure. Requirements affecting these are in terms of flexural or torsional capacity. Hence, in the Datum table the word "used" is substituted for "required".

Datum 11.6(n)	Source	Label	Number
Type of torsion reinforcement.	X		
Nominal torsional moment strength provided by concrete.	DLT 11.6(i)	T_c	
Factored torsional moment at section.	X	T_u	
Factored shear force at section.	X	V_u	
Factor relating shear and torsional stress properties.	DLT 11.6(i)	C_t*	
Area of one leg of a closed stirrup resisting torsion within a distance, s.	X	A_t	
Longer center-to-center dimension of closed rectangular stirrup.	X	y_1	
Shorter center-to-center dimension of closed rectangular stirrup.	X	x_2	
Coefficient as a function of y_1/x_1.			
Specified yield strength of nonprestressed reinforcement, psi.	X	f_y	
Spacing of shear or torsion reinforcement in direction parallel to longitudinal reinforcement, in.	X	s	
Web width, or diameter of circular section, in.	X	b_w	
Shorter overall dimension of rectangular part of cross section.	X	X	

(Continued)

* $C_t = b_w d/\Sigma x^2 y$, see DLT 11.6(i).

DLT 11.6(n)	Type of Torsion Reinforcement	1	2	3	4	ELSE
C1	Torsion reinforcement consists of closed stirrups combined with longitudinal bars?	Y	N	N	N	
C2	Torsion reinforcement consists of closed ties combined with longitudinal bars?	N	Y	N	N	
C3	Torsion reinforcement consists of spirals combined with longitudinal bars?	N	N	Y	N	
A1	Provisions = satisfied	X	X	X		
A2	Provisions ≠ satisfied				X	
A3	$\alpha_t = \min\ [0.66 + .33(y_1/x_1),\ 1.50]$	X				
A4	$T_s = \min\ [(A_t \alpha_t x_1 y_1 f_y)/S,\ 4T_c]$	X				
A5	$A_{\ell 1} = 2A_t[(x_1 + y_1)/S]$	X				
A6	$A_{\ell 2} = \left[\frac{400 \text{ x } s}{f_y}\left(\frac{T_u}{T_u + \frac{V_u}{3C_t}}\right) - 2A_t\right]\left(\frac{x_1 + y_1}{s}\right)$	X				
A7	$A_{\ell 3} = \left[\frac{400 \text{ x } s}{f_y}\left(\frac{T_u}{T_u + \frac{V_u}{3C_t}}\right) - \frac{50 b_w s}{f_y}\right]\left(\frac{x_1 + y_1}{s}\right)$	X				
A8	$A_\ell = \max.[\min\ (A_{\ell 2},\ A_{\ell 3}),\ A_{\ell 1}]$	X				
A9	DLT 11.6(o)	X				
A10	DLT Chapter 11		X	X	X	
A11	Logical Error					X

Comments:

1) DLT 11.6(n) covers Sections 11.6.7.3, 11.6.9.1, 11.6.9.3, and 11.6.9.4.

2) Section 11.6.9.2 is covered in Section 11.5 DLT.

3) Section 11.6.7.3 states that "Torsion reinforcement shall...," however, minimum area provisions and provisions of 11.6.9.1 and 11.6.9.3 apply only to torsion reinforcement which consists of closed stirrups combined with longitudinal bars.

Datum 11.6(o)	Source	Label	Number
Spacing of torsion reinforcement in direction parallel to longitudinal reinforcement, in.	X	s	
Shorter center-to-center dimension of closed rectangular stirrup.	X	x_1	
Longer center-to-center dimension of closed rectangular stirrup.	X	y_1	

DLT 11.6(o) Spacing Limits		1	2
C1	$s \le \text{min.} \left[\frac{(x_1+y_1)}{4}, 12 \right]$?	Y	N
A1	Provisions = satisfied	X	
A2	Provisions ≠ satisfied		X
A3	DLT 11.6(p)	X	X

Comment: 1) DLT 11.6(o) covers 11.6.8.1.

Datum 11.6(p)	Source	Label	Number
If longitudinal bars greater or equal to number three are distributed around perimeter.	X		
Spacing of shear or torsion reinforcement in direction perpendicular to longitudinal reinforcement, in.	X	s_2	
Is there a bar in each corner of the stirrup.	X		

DLT 11.6(p) Spacing Limits		1	2	3	4	
C1	Longitudinal bars greater or equal to #3 distributed around perimeter?	Y	Y	Y	N	ELSE
C2	$s_2 \leq 12$?	Y	Y	N		
C3	One bar in each corner?	Y	N	I		
A1	Provisions = satisfied	X				
A2	Provisions ≠ satisfied		X	X	X	
A3	DLT 11.6(q)	X	X	X	X	
A4	Logical Error					X

Comments: 1) DLT 11.6(p) covers Section 11.6.8.2.

Datum 11.6(q)	Source	Label	Number
Total area of longitudinal reinforcement to resist torsion, sq in.	X	$A_{\ell p}$	
Required area of longitudinal bars to resist torsion, sq in.	DLT 11.6(n)	A_{ℓ}	

DLT 11.6(q) Required Area of Longitudinal Reinforcement		1	2
C1	$A_{\ell p} \geq A_{\ell}$?	Y	N
A1	Provisions = satisfied	X	
A2	Provisions ≠ satisfied		X
A3	DLT 11.6(n)	X	X

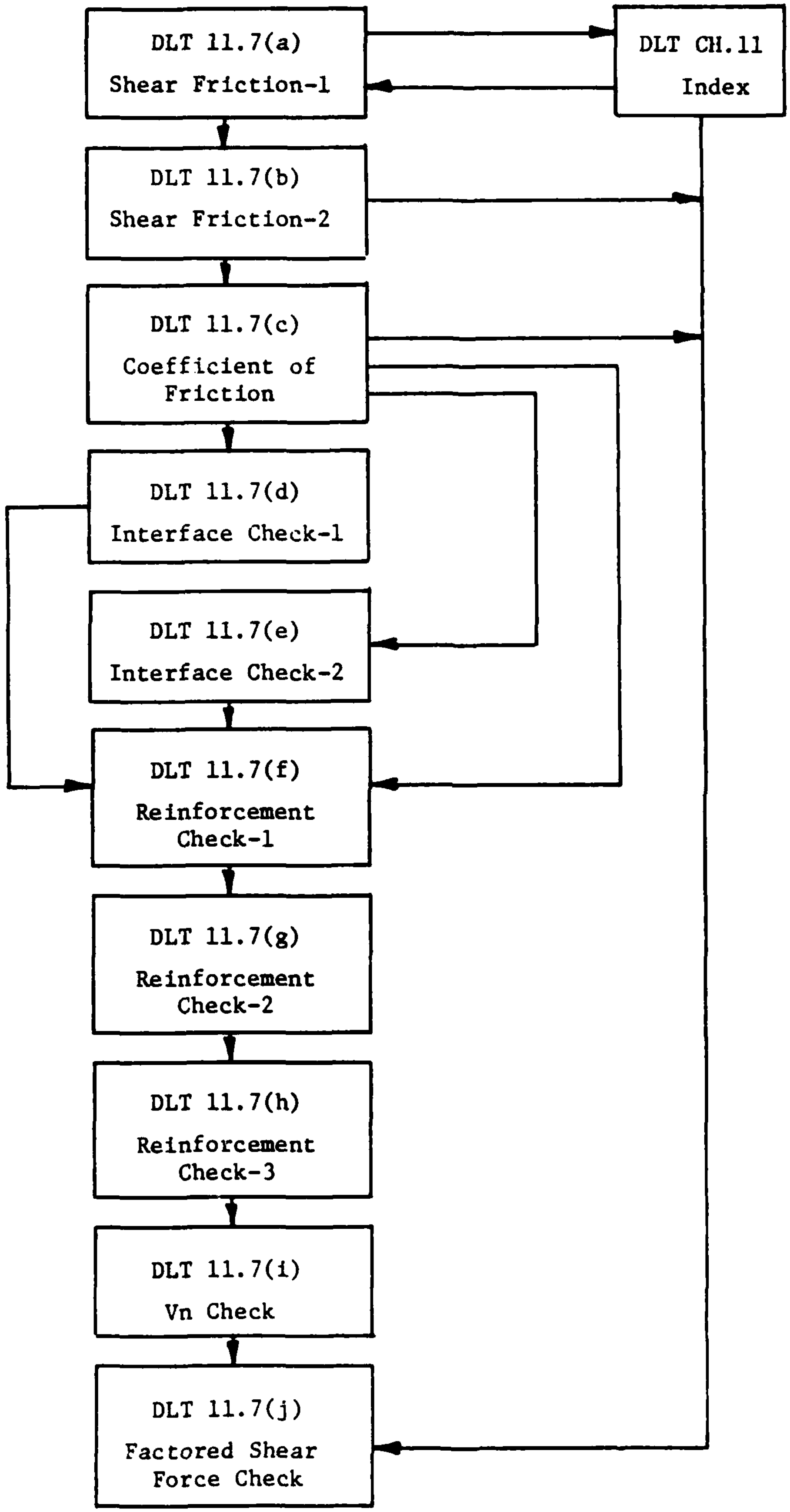
Comment: 1) DLT 11.6(q) partially covers Section 11.6.9.3.

Datum 11.6(r)	Source	Label	Number
Factored torsional moment at section.	X	T_u	
Strength reduction factor.	X	ϕ	
Nominal torsional moment strength provided by torsional reinforcement.	DLT 11.6(n)	T_s	
Nominal torsional moment strength provided by concrete.	DLT 11.6(i)	T_c	

DLT 11.6(r) Torsional Moment Strength		1	2
C1	$T_u < \phi(T_c + T_s)$?	Y	N
A1	Provisions = satisfied	X	
A2	Provisions ≠ satisfied		X
A3	DLT Ch. 11	X	X

Comments: 1) DLT 11.6(r) covers Section 11.6.5.

Section 11.7 Map



Section 11.7 Shear Friction

Datum 11.7(a)	Source	Label	Number
If shear is transferred across a given plane.	X		
If provisions of Section 11.7 are applied.	X		

DLT 11.7(a) Shear Friction-1		1	2	3	4
C1	Shear transferred across a given plane?*	Y	Y	N	ELSE
C2	Provisions of this section applied?	Y	N		
A1	Provisions = satisfied	X	X		
A2	DLT 11.7(b)	X			
A3	DLT Chapter 11		X	X	
A4	Logical Error				X

Comments:

1) DLT 11.7(a) covers Section 11.7.1.

2) Due to the use of "may be" in Section 11.7.1, application of the provisions of Section 11.7 is optional.

* Such as an existing or potential crack, an interface between dissimilar materials, or an interface between two concretes cast at different times.

Datum 11.7(b)	Source	Label	Number
If crack is assumed to occur along the shear plane.	X		
If relative displacement along the assumed crack resisted by friction maintained by shear-friction reinforcement across the assumed crack.	X		
If shear-friction reinforcement placed approximately perpendicular to the assumed crack.	X		

DLT 11.7(b) Shear Friction-2		1	2	3	4	
C1	Crack assumed to occur along the shear plane?	Y	Y	Y	N	E
C2	Relative displacement along the assumed crack resisted by friction maintained by shear-friction reinforcement across the assumed crack?	Y	Y	N		L S
C2	Shear-friction reinforcement placed approximately perpendicular to the assumed crack?	Y	N			E
A1	Provision = satisfied	X				
A2	Provision ≠ satisfied		X	X	X	
A3	DLT 11.7(c)	X				
A4	DLT Ch. 11		X	X	X	
A5	Logical Error					X

Comments: 1) DLT 11.7(b) covers section 11.7.2.

Datum 11.7(c)	Source	Label	Number
If concrete placed monolithically	X		
If concete placed against hardened concrete	X		
If concrete placed against as-rolled structural steel	X		

DLT 11.7(c)	Coefficient of Friction	1	2	3	4	5
C1	Concrete placed monolithically?	Y	N	N	N	E
C2	Concrete placed against hardened concrete?	N	Y	N	N	L
C3	Concrete placed against as-rolled structural steel	N	N	Y	N	S E
A1	$\mu = 1.4$, DLT 11.7(f)	X				
A2	$\mu = 1.0$, DLT 11.7(d)		X			
A3	$\mu = 0.7$, DLT 11.7 (e)			X		
A4	No provision, DLT Ch. 11				X	
A5	Logical error					X

Comments: 1) DLT 11.7(c) covers section 11.7.5.

Datum 11.7(d)	Source	Label	Number
Condition of interface between new concrete and previously hardened concrete.	X		

DLT 11.7(d)	Interface Check-1	1	2
C1	Interface for shear transfer clean, free of laitance, and intentionally roughened to a full amplitude of approximately 1/4 inch?	Y	N
A1	Provision = satisfied	X	
A2	Provision ≠ satisfied		X
A3	DLT 11.7(f)	X	X

Comments: 1) DLT 11.7(d) covers Section 11.7.9.

Datum 11.7(e)	Source	Label	Number
Condition of steel surface at concrete-steel interface	X		

DLT 11.7(e) Interface Check-2		1	2
C1	Surface of steel clean and free of paint?	Y	N
A1	Provision = satisfied	X	
A2	Provision ≠ satisfied		X
A3	DLT 11.7(f)	X	X

Comments: 1) DLT 11.7(e) covers Section 11.7.10.

Datum 11.7(f)	Source	Label	Number
Yield Strength of Reinforcement	X		

DLT 11.7(f) Reinforcement Check-1		1	2
C1	fy $\leq$ 60000 psi?	Y	N
A1	Provision = satisfied	X	
A2	Provision $\neq$ satisfied		X
A3	DLT 11.7(g)	X	X

Comments: 1) DLT 11.7(f) covers Section 11.7.6.

2) It is assumed here that "Design Yield Strength" in section 11.7.6 is synonymous with "Specified Yield Strength", fy.

Datum 11.7(g)	Source	Label	Number
If direct tension across the assumed crack	X		
If additional reinforcement was provided	X		

DLT 11.7(g)	Reinforcement Check-2	1	2	3	4
C1	Direct tensions across assumed crack?	Y	Y	N	ELSE
C2	Additional reinforcement provided?	Y	N		
A1	Provision = satisfied	X			
A2	Provision ≠ satisfied		X		
A3	DLT 11.7(h)	X	X	X	
A4	Logical error				X

Comments: 1) DLT 11.7(g) covers Section 11.7.7.

Datum 11.7(h)	Source	Label	Number
Quality of reinforcement distribution across assumed crack	X		
If shear-friction reinforcement adequately anchored on both sides by embedment, hooks, or welding to special devices	X		

DLT 11.7(h)	Reinforcement Check-3	1	2	3	4
C1	Shear-friction reinforcement well distributed across the assumed crack?	Y	Y	N	N
C2	Shear-friction reinforcement adequately anchored on both sides by embedment, hooks, or welding to special devices?	Y	N	Y	N
A1	Provision = satisfied	X			
A2	Provision ≠ satisfied		X	X	X
A3	DLT 11.7(i)	X	X	X	X

Comments: 1) DLT 11.7(h) covers Section 11.7.8.

Datum 11.7(i)	Source	Label	Number
Area of shear-friction reinforcement.	X	Av_t	
Design (specified) yield strength.	X	f_y	
Coefficient of friction.	DLT 11.7(c)	μ	
Nominal shear strength.	X	V_n	
Method of computing nominal shear strength.	X		
Specified strength of concrete.	X	f'_c	
Area of concrete resisting shear transfer.	X	A_c	

DLT 11.7(i) V_n Check		1	2	3	
C1	V_n computed by $Av_t\ f_y\ \mu$?	Y	Y	N	E L S E
C2	$V_n = Av_t\ f_y\ \mu$?	Y	Y	I	
C3	$V_n \leq \max\left[0.2\ f'_c A_c,\ 800\ A_c{*}\right]$?	Y	N	I	
A1	Provision = satisfied	X			
A2	Provision ≠ satisfied		X	X	
A3	DLT 11.7(j)	X	X	X	
A4	Logical Error				X

Comment:

1) DLT 11.7(i) covers Sections 11.7.3 and 11.7.4.

---

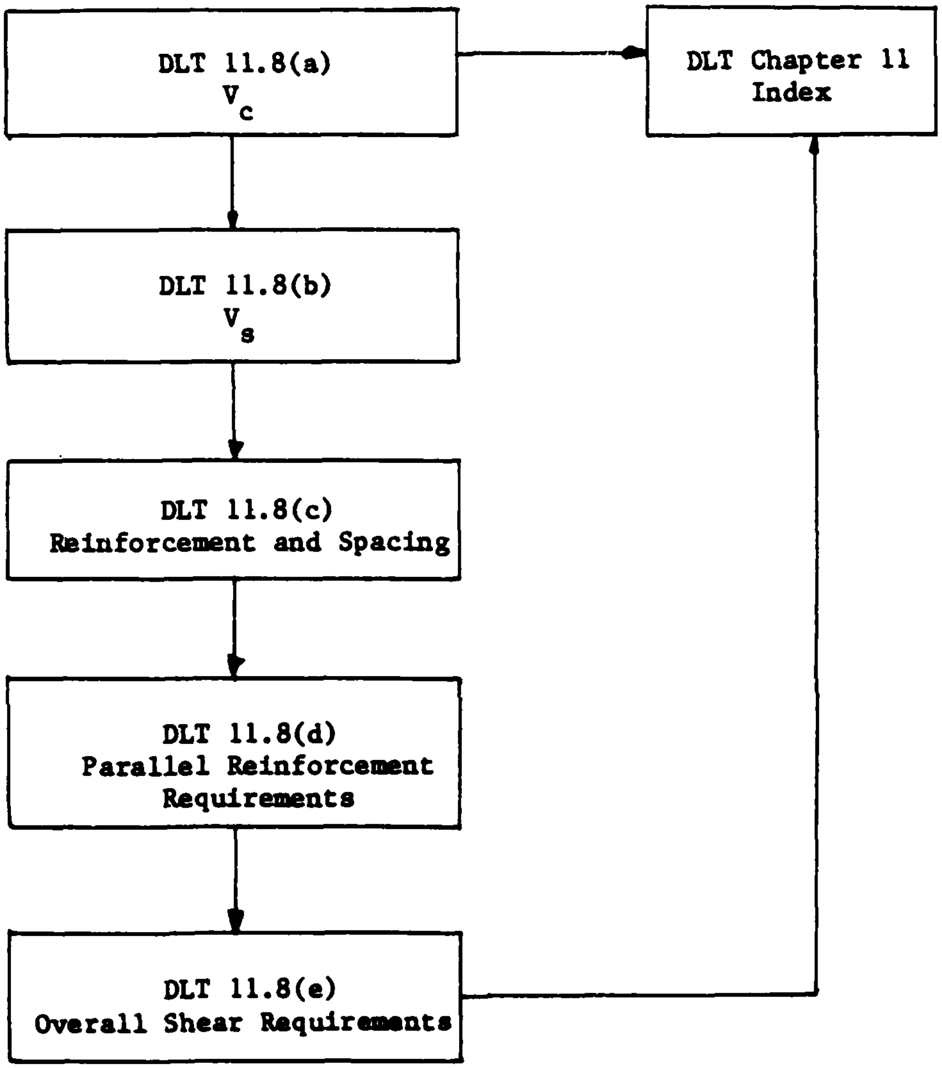
* 800 A_c is in pounds.

Datum 11.7(j)	Source	Label	Number
Factored shear force at section considered	X	V_u	
Normal shear strength	DLT11.7(i)	V_n	
Shear reduction factor	Sec. 9.3	ϕ	

DLT 11.7(j) Factored Shear Force Check		1	2
C1	$V_u \leq \phi V_n$?	Y	N
A1	Provision = satisfied	X	
A2	Provision ≠ satisfied		X
A3	DLT Ch. 11	X	X

Comment: 1) DLT 11.7(j) covers Section 11.7.3 (Eq 11-1).

Section 11.8 Map



Section 11.8 Special Provisions for Deep Flexural Members

Datum 11.8(a)	Source	Label	Number
Clear span measured face-to-face of supports.	X	ℓn	
Distance from extreme compression fiber to centroid of longitudinal tension reinforcement, but need not be less than 0.80h for prestressed members, in. (For circular sections, d need not be less than the distance from extreme compression fiber to centroid of tension reinforcement in opposite half of member.)	X	d	
If member is loaded at top or compression face.	X		
Square root of specified compressive strength of concrete, psi.	X	$\sqrt{f'_c}$	
Web width or diameter of circular section, in.	X	b_w	
Reinforcement ratio.*	X	ρ_w	
Factored shear force at critical section.**	X	V_u	
Factored moment at critical section occurring simultaneously with V_u.	X	M_u	
Area of nonprestressed tension reinforcement.	X	A_s	
Shear span, distance between concentrated load and support.	X	a	

(Continued)

* $\rho_w = A_s/b_w d$.

** Critical section is at a distance from the face of the support equal to min [0.15 ℓn , d] for uniformly loaded beams and min [0.50 a , d] for beams with concentrated loads.

DLT 11.8(a) V_c		1	2	3
C1	$\ell n/d \leq 5$?	Y	Y	N
C2	Member loaded at top or compression face?	Y	N	I
A1	Provisions of Section 11.8 do not apply DLT Chapter 11		X	X
A2	$V_{c1} = 2\sqrt{f'_c}\ b_w d$	X		
A3	$V_{c2} = \left\{\min\left[\left(3.5 - 2.5\ \frac{M_u}{V_u d}\right), 2.5\right]\left[\left(1.9\sqrt{f'_c} + 2500\rho_w\ \frac{V_u d}{M_u}\right) b_w d\right]\right\}$	X		
A4	$V_c = \min\left[\max\left[V_{c1}, V_{c2}\right],\ 6\sqrt{f'_c}\ b_w d\right]$	X		
A5	DLT 11.8(b)	X		

Comments:

1) DLT 11.8(a) covers Sections 11.8.1, 11.8.4, 11.8.5, and 11.8.6.

2) In the absence of reinforcement, $V_n = V_c$ and is subject to the limits of Section 11.8.3. The limit on V_c in Section 11.8.6 (A1 of above) is less than the limits of Section 11.8.3, hence no check is made.

Datum 11.8(b)	Source	Label	Number
Nominal shear strength provided by concrete.	DLT 11.8(a)	V_c	
Factored shear force at section.	X	V_u	
Strength reduction factor.	X	ϕ	
Clear span measured face-to-face of supports.	X	ℓn	
Area of shear reinforcement within a distance s, or area of shear reinforcement perpendicular to flexural tension reinforcement within a distance s for deep flexural members, sq in.	X	A_v	
Area of shear reinforcement parallel to flexural tension reinforcement within a distance s_2, sq in.	X	A_{vh}	
Spacing of shear or torsion reinforcement in direction parallel to longitudinal reinforcement, in.	X	s	
Spacing of shear or torsion reinforcement in direction perpendicular to longitudinal reinforcement or spacing of horizontal reinforcement in wall, in.	X	s_2	
Distance from extreme compression fiber to centroid of longitudinal tension reinforcement, but need not be less than 0.80h for prestressed members, in. (For circular sections, d need not be less than the distance from extreme compression fiber to centroid of tension reinforcement in opposite half of member.)	X	d	
Specified yield strength of non-prestressed reinforcement, psi.	X	f_y	
If shear reinforcement provided.			

(Continued)

DLT 11.8(b) V_s		1	2	3
C1	$V_u > \phi V_c$	Y	Y	N
C2	Shear reinforcement provided?	Y	N	I
A1	Provision = satisfied	X		X
A2	Provision ≠ satisfied		X	
A3	$V_s = \left[\frac{A_v}{s} \left(\frac{1 + \frac{\ell n}{d}}{12} \right) + \frac{A_{vh}}{s_2} \left(\frac{11 - \frac{\ell n}{d}}{12} \right) \right] f_y d$	X		
A4	DLT Ch. 11		X	X
A5	DLT 11.8(c)	X		

Comments: 1) DLT 11.8(b) covers Section 11.8.7.

Datum 11.8(c)	Source	Label	Number
Area of shear reinforcement within a distance s, or area of shear reinforcement perpendicular to flexural tension reinforcement within a distance s for deep flexural members, sq in.	X	A_v	
Width of compression force of member, in.	X	b	
Spacing of shear or torsion reinforcement in direction parallel to longitudinal reinforcement.	X	s	
Distance from extreme compression fiber to centroid of longitudinal tension reinforcement, but need not be less than 0.80h for prestressed members, in. (For circular sections, d need not be less than the distance from extreme compression fiber to centroid of tension reinforcement in opposite half of member.)	X	d	

DLT 11.8(c)	Reinforcement and Spacing	1	2	3
C1	$A_v \geq 0.0015$ bs?	Y	Y	N
C2	$s \leq \min[d/5,\ 18\ \text{in}]$?	Y	N	I
A1	Provision = satisfied	X		
A2	Provision ≠ satisfied		X	X
A3	DLT 11.8(d)	X	X	X

Comments: 1) DLT 11.8(c) covers Section 11.8.8.

Datum 11.8(d)	Source	Label	Number
Area of shear reinforcement parallel to flexural tension reinforcement within a distance s_2, sq in.	X	A_{vh}	
Spacing of shear or torsion reinforcement in direction perpendicular to longitudinal reinforcement or spacing of horizontal reinforcement in wall.	X	s_2	
Width of compression face of member.	X	b	
Distance from extreme compression fiber to centroid of longitudinal tension reinforcement, but need not be less than 0.80h for prestressed members, in. (For circular sections, d need not be less than the distance from extreme compression fiber to centroid of tension reinforcement in opposite half of member.)	X	d	

DLT 11.8(d) Parallel Reinforcement Requirements		1	2	3
C1	$A_{vh} \geq 0.0025\ bs_2$	Y	Y	N
C2	$s_2 \leq \min[d/3,\ 18\ in]$	Y	N	I
A1	Provision = satisfied	X		
A2	Provision ≠ satisfied		X	X
A3	DLT 11.8(e)	X	X	X

Comments: 1) DLT 11.8(d) covers Section 11.8.9.

Datum 11.8(e)	Source	Label	Number
Factored shear force at critical section.*	X	V_u	
Nominal shear strength provided by concrete.	DLT 11.8(a)	V_c	
Nominal shear strength provided by shear reinforcement.	DLT 11.8(b)	V_s	
Strength reduction factor.	X	ϕ	

DLT 11.8(e) Overall Shear Requirements		1	2	3
C1	Shear reinforcement at the critical section used throughout span?	Y	Y	N
C2	$V_u \leq \phi(V_c + V_s)$?	Y	N	I
A1	Provision = satisfied	X		
A2	Provision ≠ satisfied		X	X
A3	DLT Chapter 11	X	X	X

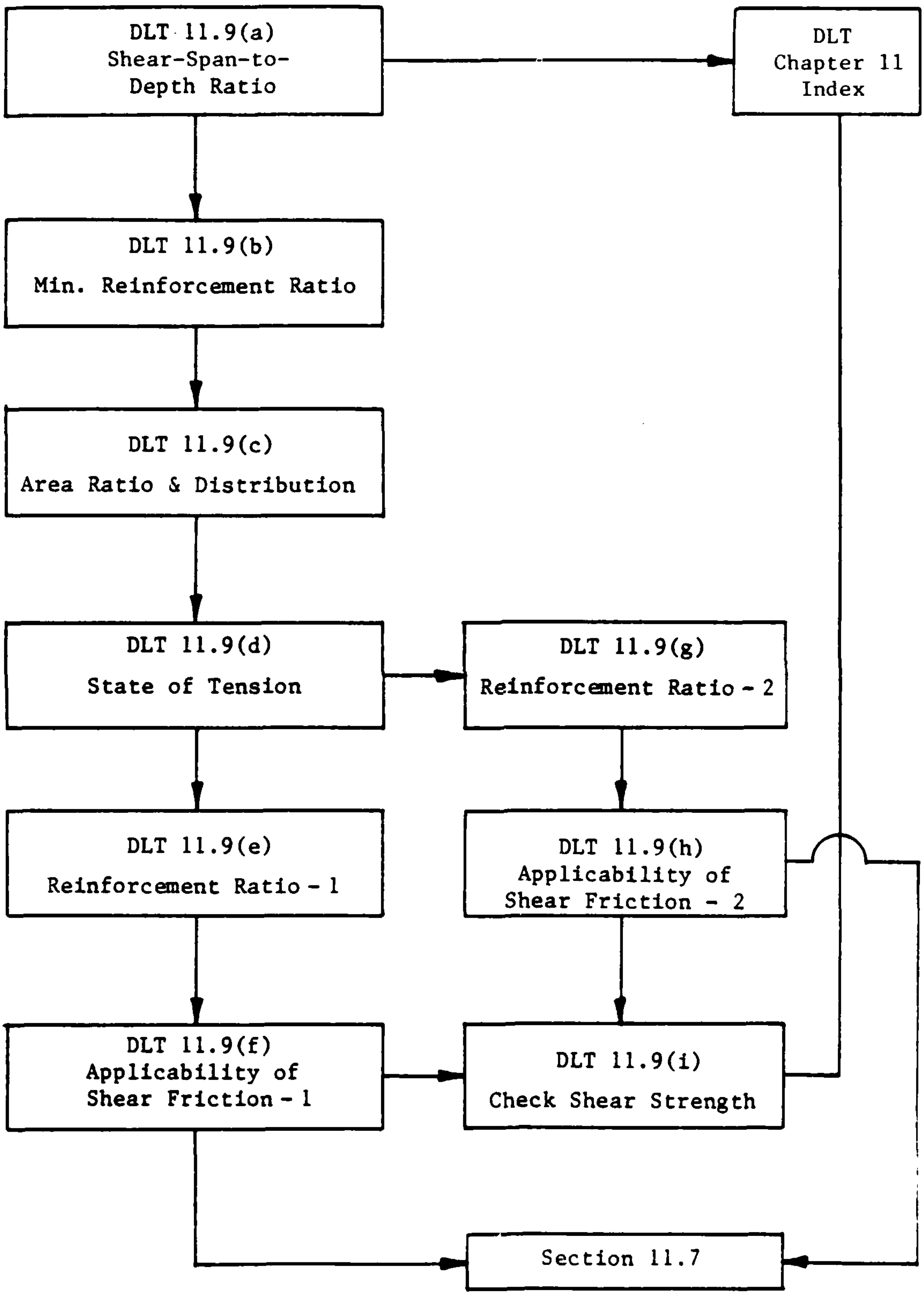
Comments:

1) DLT 11.8(e) covers Sections 11.8.10 and 11.1.1.

2) Note that V_u as used here is the value at the critical section.

* Critical section is at a distance from the face of the support equal to min[0.15 ℓn, d] for uniformly loaded beams and min[0.50 a, d] for beams with concentrated loads.

Section 11.9 Map



Section 11.9 Special Provisions for Brackets and Corbels

Datum 11.9(a)	Source	Label	Number
Shear span, distance between concentrated load and the face of the support.	X	a	
Distance* from extreme compression fiber to centroid of longitudinal tension reinforcement, but need not be less than 0.80h for prestressed members, in. (For circular sections, d need not be less than the distance from extreme compression fiber to centroid of tension reinforcement in opposite half of member.)	X	d	

DLT 11.9(a) Shear-Span-to-Depth		1	2
C1	$a/d \leq 1$?	Y	N
A1	DLT 11.9(b)	X	
A2	Provisions for Section 11.9 do not apply		X
A3	DLT Chapter 11		X

Comment:

1) DLT 11.9(a) covers Section 11.9.1.

---

* The distance d shall be measured at a section adjacent to face of support but shall not be taken greater than twice the depth of bracket or corbel at outside edge of bearing area.

Datum 11.9(b)	Source	Label	Number
Specified compressive strength of concrete, psi.	X	f'_c	
Specified yield strength of nonprestressed reinforcement, psi.	X	f_y	
Area of nonprestressed tension reinforcement, sq in.	X	A_s	
Width of compression face of member, in.	X	b	
Distance from extreme compression fiber to centroid of longitudinal tension reinforcement, but need not be less than 0.80h for prestressed members, in. (For circular sections, d need not be less than the distance from extreme compression fiber to centroid of tension reinforcement in opposite half of member.)	X	d	
Ratio of nonprestressed tension reinforcement.*	X	ρ	

DLT 11.9(b) Min. Reinforcement Ratio		1	2
C1	$\rho \geq 0.04\ (f'_c/f_y)$?	Y	N
A1	Provision = satisfied	X	
A2	Provision ≠ satisfied		X
A3	DLT 11.9(c)	X	X

Comment:

1) DLT 11.9(b) covers Section 11.9.7.

* $\rho = A_s/bd$.

Datum 11.9(c)	Source	Label	Number
If type of shear reinforcement = closed stirrups or ties.	X		
Area of shear reinforcement parallel to flexural tension reinforcement, sq in.	X	A_h	
Area of nonprestressed tension reinforcement, sq in.	X	A_s	
If horizontal shear reinforcment is uniformly distributed within two-thirds of the effective depth adjacent to flexural tension reinforcement.	X		

DLT 11.9(c) Area Ratio and Distribution		1	2	3	4
C1	Type of horizontal shear reinforcement = closed stirrups or ties?	Y	Y	Y	N
C2	$A_h \geq 0.50\ A_s$?	Y	Y	N	I
C3	Horizontal shear reinforcement uniformly distributed within 2/3 of the effective depth adjacent to flexural tension reinforcement?	Y	N	I	I
A1	Provision = satisfied	X			
A2	Provision ≠ satisfied		X	X	X
A3	DLT 11.9(d)	X	X	X	X

Comments: 1) DLT 11.9(c) covers Section 11.9.6.

Datum 11.9(d)	Source	Label	Number
If brackets and corbels are subject to tension due to restrained creep and shrinkage.	X		

DLT 11.9(d) State of Tension		1	2
C1	Brackets and corbels subject to tension due to restrained creep and shrinkage?	Y	N
A1	DLT 11.9(e)	X	
A2	DLT 11.9(g)		X

Comments: 1) DLT 11.9(d) partially covers Section 11.9.4.

Datum 11.9(e)	Source	Label	Number
Ratio* of nonprestressed tension reinforcement used in design.	X	ρ	
Specified compressive strength of concrete, psi.	X	f'_c	
Specified yield strength of nonprestressed reinforcement, psi.	X	f_y	
Area of nonprestressed tension reinforcement, sq in.	X	A_s	
Width of compression face of member, in.	X	b	
Distance from extreme compression fiber to centroid of longitudinal tension reinforcement, but need not be less than 0.80h for prestressed members, in. (For circular sections, d need not be less than the distance from extreme compression fiber to centroid of tension reinforcement in opposite half of member.)	X	d	

DLT 11.9(e) Reinforcement Ratio - 1		1	2
C1	$\rho \leq 0.13\ (f'_c/f_y)$?	Y	N
A1	Provision = satisfied	X	
A2	Provision ≠ satisfied		X
A3	DLT 11.9(f)	X	X

Comment:

1) DLT 11.9(e) partially covers Section 11.9.4.

* $\rho = A_s/bd$

Datum 11.9(f)	Source	Label	Number
Shear span, distance between concentrated load and face of support.	X	a	
Distance from extreme compression fiber to centroid of longitudinal tension reinforcement, but need not be less than 0.80h for prestressed members, in. (For circular sections, d need not be less than the distance from extreme compression fiber to centroid of tension reinforcement in opposite half of member.)	X	d	
If check per Section 11.7 is desired.	X		
Factored tensile force on bracket or corbel acting simultaneously with V_u, to be taken as positive for tension.	X	N_{uc}	
Factored shear force at section.	X	V_u	
Specified compressive strength of concrete, psi.	X	f'_c	
Web width or diameter of circular section, in.	X	b_w	

(Continued)

DLT 11.9(f) Applicability of Shear-Friction - 1		1	2	3	
C1	a/d $\leq$ 0.5?	Y	Y	N	ELSE
C2	Check per Section 11.7 desired?	Y	N		
A1	Section 11.7	X			
A2*	$\frac{N_{uc}}{V_u} = \max\left[0.20, \frac{N_{uc}}{V_u}\right]$		X	X	
A3	$V_n = \left[6.5 - 5.1\sqrt{\frac{N_{uc}}{V_u}}\right]\left[1 - 0.5\frac{a}{d}\right] \times \left(1 + \left[64 + 160\sqrt{\left(\frac{N_{uc}}{V_u}\right)^3}\right]\rho\right)\sqrt{f'_c}\, b_w d$		X	X	
A4	DLT 11.9(i)	X	X	X	
A5	Logical Error				X

Comments:

1) DLT 11.9(f) covers Section 11.9.2 and part of Section 11.9.4.

2) The checks on quantity and spacing of reinforcement required per the last phrase of Section 11.9.2 are done in the previous DLTs of this Section. It was assumed that the phrase required the imposition of the upper limit on ρ of Section 11.9.4 as well as the lower limit on ρ of Section 11.9.7.

---

* Tensile force N_{uc} shall be regarded as a live load even when tension results from creep, shrinkage, or temperature change.

Datum 11.9(g)	Source	Label	Number
Combined ratio* of nonprestressed tension reinforcement and shear reinforcement parallel to flexural reinforcement in design.	X	ρ_v	
Specified compressive strength of concrete, psi.	X	f'_c	
Width of compression face of member, in.	X	b	
Distance from extreme compression fiber to centroid of longitudinal tension reinforcement, but need not be less than 0.80h for prestressed members, in. (For circular sections, d need not be less than the distance from extreme compression fiber to centroid of tension reinforcement in opposite half of member.)	X	d	
Specified yield strength of nonprestressed reinforcement, psi.	X	f_y	
Area of shear reinforcement parallel to flexural tension reinforcement, sq in.	X	A_h	
Area of nonprestressed tension reinforcement, sq in.	X	A_s	

DLT 11.9(g) Reinforcement Ratio - 2		1	2	3
C1	$\rho_v \leq 0.20 \ (f'_c/f_y)$?	Y	Y	N
C2	$A_h \leq A_s$?	Y	N	I
A1	Provision = satisfied	X		
A2	Provision ≠ satisfied		X	X
A3	DLT 11.9(h)	X	X	X

Comment:

1) DLT 11.9(g) partially covers Section 11.9.5.

---

* $\rho_v = (A_s + A_h)/bd$.

Datum 11.9(h)	Source	Label	Number
Shear span, distance between concentrated load and face of support, in.	X	a	
Distance from extreme compression fiber to centroid of longitudinal tension reinforcement, but need not be less than 0.80h for prestressed members, in. (For circular sections, d need not be less than the distance from extreme compression fiber to centroid of tension reinforcement in opposite half of member.)	X	d	
If check per Section 11.7 is desired.	X		
Nominal shear strength.	X	V_n	
Combined ratio* of nonprestressed tension reinforcement and shear reinforcement parallel to flexural reinforcement in design.	X	ρ_v	
Area of nonprestressed tension reinforcement, sq in.	X	A_s	
Width of compression face of member, in.	X	b	
Specified compressive strength of concrete, psi.	X	f'_c	
Web width, or diameter of circular section, in.	X	b_w	

(Continued)

* $\rho_v = (A_h + A_s)/bd$.

DLT 11.9(h) Applicability of Shear Friction - 2		1	2	3	
C1	$a/d \leq 0.5$?	Y	Y	N	ELSE
C2	Check per Section 11.7 desired?	Y	N		
A1	Section 11.7	X			
A2	$V_n = 6.5(1 - 0.5\ a/d)(1 + 64\ \rho_v)(\sqrt{f'_c}\ b_w d)$		X	X	
A3	DLT 11.9(i)		X	X	
A4	Logical Error				X

Comments:

1) DLT 11.9(h) covers Section 11.9.2 and part of Section 11.9.5.

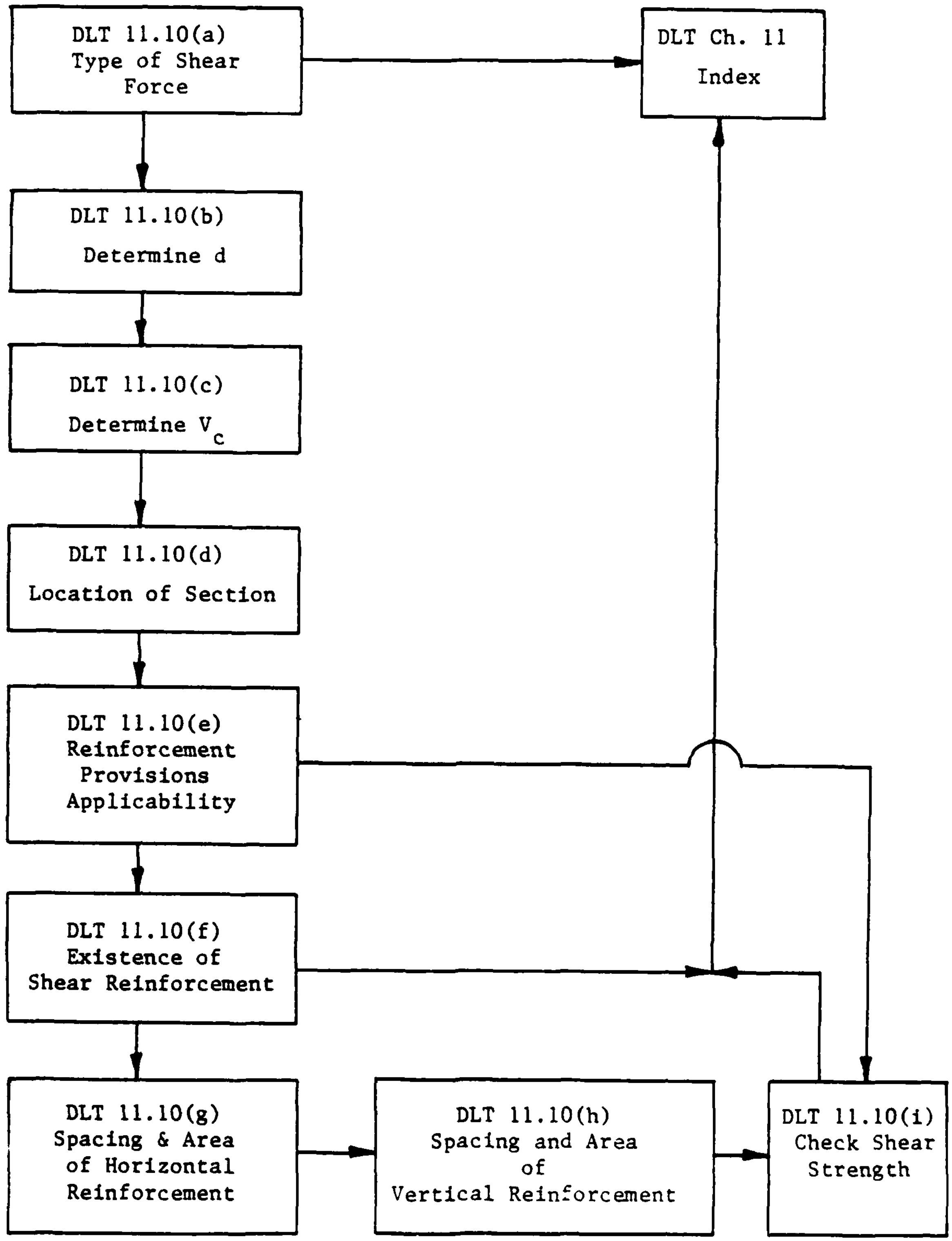
2) The checks on quantity and spacing of reinforcement per the last phrase of Section 11.9.2 are done in the previous DLTs of this section. It was assumed that the phrase required imposition of the upper limits on ρ_v of Section 11.9.5 as well as the lower limits on ρ_v of Section 11.9.7.

Datum 11.9(i)	Source	Label	Number
Factored shear force at section.	X	V_u	
Strength reduction factor.	X	ϕ	
Nominal shear strength.	DLT 11.9(f) DLT 11.9(h)	V_n	

DLT 11.9(i) Check Shear Strength		1	2
C1	$V_u \leq \phi V_n$?	Y	N
A1	Provision = satisfied	X	
A2	Provision ≠ satisfied		X
A3	DLT Ch. 11	X	X

Comments: 1) DLT 11.9(i) covers Sections 11.1.1 and 11.9.3.

Section 11.10 Map



Section 11.10 Special Provisions for Walls

Datum DLT 11.10(a)	Source	Label	Number
If design for shear force perpendicular to wall.	X		
If design for the shear force in the plane of the wall.	X		

DLT 11.10(a)		1	2	3	4
C1	Design for shear force perpendicular to wall?	Y	N	N	ELSE
C2	Design for shear force in the plane of the wall?	N	Y	N	
A1	Section 11.11	X			
A2	DLT 11.10(b)		X		
A3	No Provision DLT Ch. 11			X	
A4	Logical Error				X

Comments: 1) DLT 11.10(a) covers Section 11.10.1.

Datum 11.10(b)	Source	Label	Number
If d is determined by a strain compatibility analysis.	X		
Horizontal length of wall, in.	X	ℓ_w	
Distance from extreme compression fiber to centroid of longitudinal tension reinforcement, but need not be less than 0.80h for prestressed members, in. (For circular sections, d need not be less than the distance from extreme compression fiber to centroid of tension reinforcement in opposite half of member.)	X	d	

DLT 11.10(b)		1	2
C1	d determined by strain compatibility analysis?	Y	N
A1	$d = 0.8\ \ell_w$		X
A2	d = distance from extreme compression fiber to center of force of all reinforcement in tension.	X	
A3	DLT 11.10(c)	X	X

Comments: 1) DLT 11.10(b) covers Section 11.10.4.

Datum 11.10(c)	Source	Label	Number
Factored axial load normal to cross section occurring simultaneously with V_u, to be taken as positive for compression, negative for tension, and to include effects of tension due to creep and shrinkage.	X	N_u	
Factored moment at section.	X	M_u	
Horizontal length of wall, in.	X	ℓ_w	
Distance from extreme compression fiber to centroid of longitudinal tension reinforcement, but need not be less than 0.80h for prestressed members, in. (For circular sections, d need not be less than the distance from extreme compression fiber to centroid of tension reinforcement in opposite half of member.)	DLT 11.10(b)	d	
Specified compressive strength of concrete, psi.	X	f'_c	
Overall thickness of member, in.	X	h	
Web width, or diameter of circular section, in.	X	b_w	
Gross area of section, sq in.	X	A_g	
Nominal shear strength provided by concrete.			

(Continued)

DLT 11.10(c) Determine V_c		1	2	3	4
C1	N_u compression?	Y	Y	N	N
C2	$M_u/V_u - \ell_w/2 < 0$?	Y	N	Y	N
A1	$V_{c1} = 2\sqrt{f'_c}\ hd$	X	X		
A2	$V_{c2} = 2\left(1 + N_u/500\ A_g\right)\sqrt{f'_c}\ b_w d$			X	X
A3	$V_{c3} = 3.3\sqrt{f'_c}\ hd + N_u d/4\ \ell_w$	X	X	X	X
A4	$V_{c4} = \left[0.6\sqrt{f'_c} + \dfrac{\ell_w\left(1.25\sqrt{f'_c} + 0.2\ N_u/\ell_w h\right)}{\left(M_u/V_u - \ell_w/2\right)}\right] hd$		X		X
A5	$V_c = \max\left[V_{c1}, V_{c3}\right]$	X			
A6	$V_c = \max\left[V_{c1}, \min(V_{c3}, V_{c4})\right]$		X		
A7	$V_c = \max\left[V_{c2}, V_{c3}\right]$			X	
A8	$V_c = \max\left[V_{c2}, \min(V_{c3}, V_{c4})\right]$				X
A9	DLT 11.10(d)	X	X	X	X

Comments: 1) DLT 11.10(c) covers Sections 11.10.5 and 11.10.6.

Datum 11.10(d)	Source	Label	Number
If section located closer to wall base than a distance min[ℓ_w/2, one-half of wall height].	X		
If designed for V_c computed at min[ℓ_w/2, one-half of wall height].	X		

DLT 11.10(d)		1	2	3
C1	Section located closer to wall base than min[ℓ_w/2, one-half wall height]?	Y	N	N
C2	Designed for V_c computed at min[ℓ_w/2, one-half wall height]?	I	Y	N
A1	Provision = satisfied	X		X
A2	Provision ≠ satisfied		X	
A3	DLT 11.10(e)	X	X	X

Comments: 1) DLT 11.10(d) covers Section 11.10.7.

2) It is assumed here that the location of computing V_c referred to in the last phrase of Section 11.10.7 is also the lesser of ℓ_w/2 or one-half wall height.

Datum 11.10(e)	Source	Label	Number
Strength reduction factor.	X	ϕ	
Nominal shear strength provided by concrete.	DLT 11.10(c)	V_c	
Factored shear force at section.	X	V_u	
If reinforcement provided in accordance with Ch. 14.	X		

DLT 11.10(e) Reinforcement Provisions Applicability		1	2	3	4
C1	$V_u < \phi V_c/2$?	Y	Y	N	N
C2	Reinforcement provided in accordance with Ch. 14?	Y	N	Y	N
A1	Provision = satisfied	X			X
A2	Provision ≠ satisfied		X	X	
A3	$V_n = V_c$	X	X		
A4	DLT 11.10(f)			X	X
A5	DLT 11.10(i)	X	X		

Comments: 1) DLT 11.10(e) partially covers Section 11.10.8.

2) Note in DR#3 that if $V_u > \phi V_c/2$ and reinforcement has been provided per Ch. 14, an error is indicated and a check will be made per Section 11.10.9.

3) The last sentence of Section 11.10.8 appears to conflict with 11.10.9.1. Section 11.10.8 compares V_u with $\frac{1}{2}\phi V_c$ and in Section 11.10.9.1 V_u is compared to ϕV_c with respect to providing shear reinforcement. It is assumed here that Section 11.10.9 applies if $V_u > \frac{1}{2}\phi V_c$.

4) The first sentence of 11.10.8 indicates that if $V_u < \phi V_c/2$ shear reinforcement should be provided in accordance with Section 11.10.9 <u>or</u> in accordance with Chapter 14. However, per the first phrase of 11.10.9.1, Section 11.10.9 does not apply where $V_u < \phi V_c$ (or even $V_u < 1/2\ \phi V_c$ as assumed here, see Comment 3). Therefore in DR#2 a violation is indicated if reinforcement is not provided per Chapter 14.

Datum 11.10(f)	Source	Label	Number
Distance from extreme compression fiber to centroid of longitudinal tension reinforcement, but need not be less than 0.80h for prestressed members, in. (For circular sections, d need not be less than the distance from extreme compression fiber to centroid of tension reinforcement in opposite half of member.)	DLT 11.10(b)	d	
Area of shear reinforcement within a distance s, or area of shear reinforcement perpendicular to flexural tension reinforcement within a distance s for deep flexural members.	X	A_v	
Specified yield strength of nonprestressed reinforcement, psi.	X	f_y	
Spacing of shear or torsion reinforcement in direction perpendicular to longitudinal reinforcement or spacing of horizontal reinforcement in wall, in.	X	s_2	
If shear reinforcement is provided.	X		
Nominal shear strength provided by concrete.	DLT 11.10(c)	V_c	
Specified compressive strength of concrete, psi.	X	f'_c	
Overall thickness of member.	X	h	

(Continued)

DLT 11.10(f) Existence of Shear Reinforcement		1	2
C1	Shear reinforcement provided?	Y	N
A1	$V_s = (A_v f_y d)/s_2$	X	
A2	$V_n = \min[(V_s+V_c),\ 10\sqrt{f'_c}\ hd]$	X	
A3	Provision = satisfied		X
A4	DLT 11.10(g)	X	
A5	DLT Ch. 11		X

Comments: 1) DLT 11.10(f) covers Sections 11.10.9.1 and 11.10.3.

Datum 11.10(g)	Source	Label	Number
Gross concrete area of vertical section, sq in.	X	A_{gv}	
Overall thickness of member, in.	X	h	
Horizontal length of wall, in.	X	ℓ_w	
Spacing of shear or torsion reinforcement in direction perpendicular to longitudinal reinforcement or spacing of horizontal reinforcement in wall, in.	X	s_2	
Ratio of horizontal shear reinforcement area to gross concrete area of vertical section.	X	ρ_h	

DLT 11.10(g) Spacing and Area of Horizontal Reinforcement		1	2	3
C1	$s_2 \leq \min[18 \text{ in}, \ell_w/5, 3h]$?	Y	Y	N
C2	$\rho_h \geq 0.0025\ A_{gv}$?	Y	N	I
A1	Provision = satisfied	X		
A2	Provision ≠ satisfied		X	X
A3	DLT 11.10(h)	X	X	X

Comments: 1) DLT 11.10(g) covers Sections 11.10.9.2 and 11.10.9.3.

Datum 11.10(h)	Source	Label	Number
Spacing of vertical reinforcement in wall, in.	X	s_1	
Horizontal length of wall, in.	X	ℓ_w	
Overall thickness of member, in.	X	h	
Ratio of horizontal shear reinforcement area to gross concrete area of vertical section.	X	ρ_h	
Ratio of vertical shear reinforcement area to gross concrete area of horizontal section.	X	ρ_n	
Total height of wall from base to top, in.	X	h_w	

DLT 11.10(h) Spacing and Area of Vertical Reinforcement		1	2	3
C1	$s_1 \leq \min[\ell_w/3,\ 3h,\ 18\text{ in}]$?	Y	Y	N
C2	$\rho_h \geq \rho_n \geq \max\left[\left(0.0025 + 0.5\left(2.5 - \frac{h_w}{\ell_w}\right)\left(\rho_h - .0025\right)\right), 0.0025\right]$?	Y	N	I
A1	Provision = satisfied	X		
A2	Provision ≠ satisfied		X	X
A3	DLT 11.10(i)	X	X	X

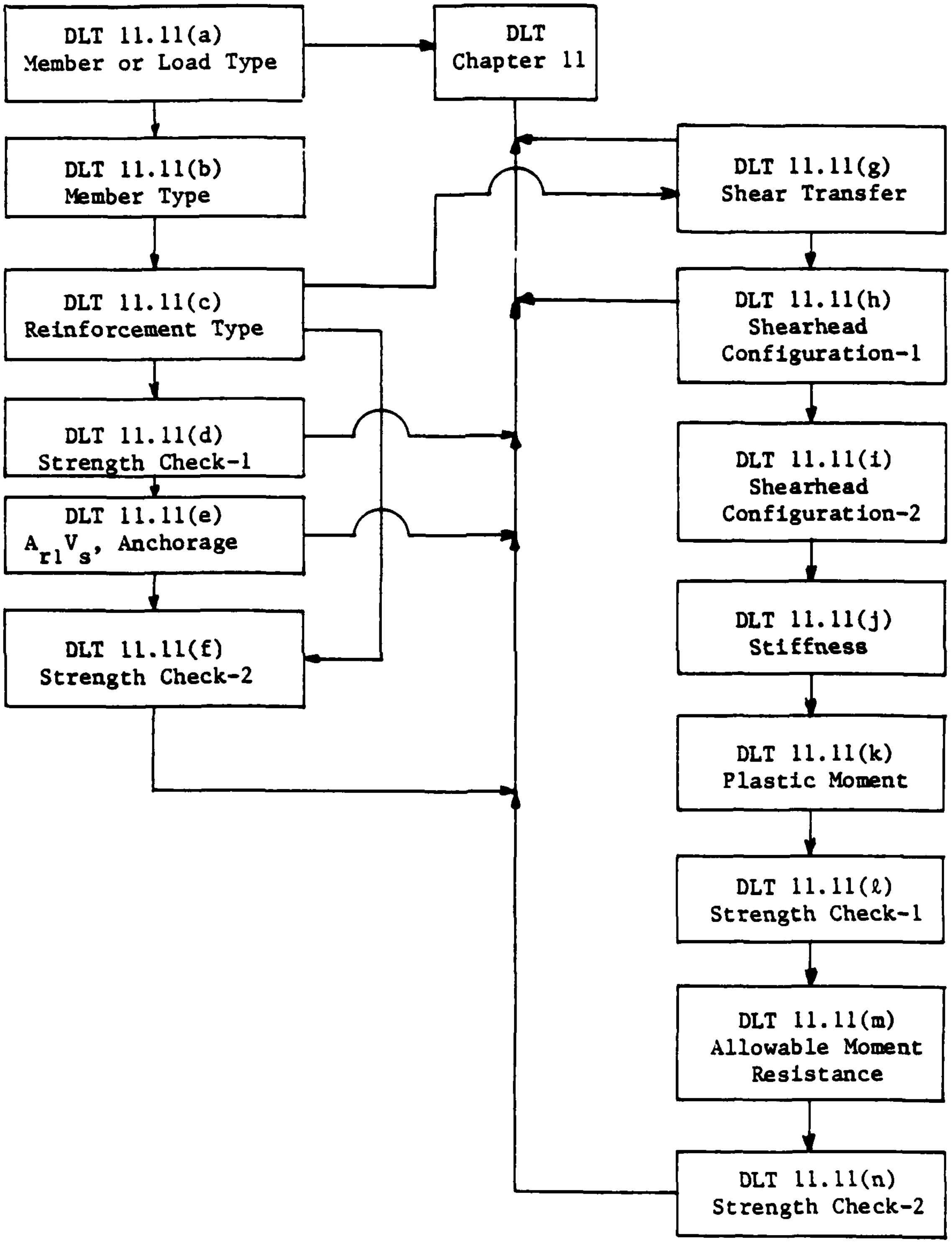
Comments: 1) DLT 11.10(h) covers Section 11.10.9.4 and 11.10.9.5.

Datum 11.10(i)	Source	Label	Number
Factored shear force at section.	X	V_u	
Strength reduction factor.	X	ϕ	
Nominal shear strength.	DLT 11.10 (f)	V_n	

DLT 11.10(i) Check Shear Strength		1	2
C1	$V_u \leq \phi V_n$?	Y	N
A1	Provision = satisfied	X	
A2	Provision $\neq$ satisfied		X
A3	DLT Ch. 11	X	X

Comments: 1) DLT 11.10(i) covers Sections 11.1 and 11.10.2.

Section 11.11 Map



Section 11.11 Special Provisions for Slabs and Footings

Datum 11.11(a)	Source	Label	Number
If shear strength check of slab or footing in the vicinity of concentrated loads or reaction is desired.	X		

DLT 11.11(a) Member or Load Type		1	2
C1	Shear strength check of slab or footing in the vicinity of concentrated load or reaction?	Y	N
A1	DLT 11.11(b)	X	
A2	DLT Ch. 11		X

Comments: 1) DLT 11.11(a) covers Section 11.11.1.

Datum 11.11(b)	Source	Label	Number
If member is slab or footing with two-way action.	X		

DLT 11.11(b) Member Type		1	2
C1	Member = slab or footing with two-way action?	Y	N
A1	DLT 11.11(c)	X	
A2	No Provision, DLT Ch. 11		X

Comments: 1) DLT 11.11(b) partially covers Section 11.11.1.2.

Datum 11.11(c)	Source	Label	Number
If shear reinforcement provided.	X		
If shear reinforcement is equal to bars or wires.	X		
If shear reinforcement is equal to steel "I" of channel shapes (shearheads).	X		
If opening in slab at a distance $\leq$ 10 times slab thickness from a concentrated load or reaction area <u>or</u> opening in slab within column strip.	X		
Ratio of long side to short side of concentrated load or reaction area.	X	β_c	
Square root of specified compressive strength of concrete, psi.	X	$\sqrt{f'_c}$	
Perimeter of critical section 1.*	X	b_{o1}	
Distance from extreme compression fiber to centroid of longitudinal tension reinforcement, but need not be less than 0.80h for prestressed members, in. (For circular sections, d need not be less than the distance from extreme compression fiber to centroid of tension reinforcement in opposite half of member.)	X	d	

Comment:

1) DLT 11.11(c) covers Sections 11.11.2, 11.11.3.4, and 11.11.5.

(Continued)

---

* Critical Section 1 is perpendicular to the plane of the slab and located so that its perimeter, b_{o1} , is a minimum. The critical section is $\geq d/2$ from the perimeter of concentrated load or reaction area.

DLT 11.11(c)		1	2	3	4	5	6	7	8	
C1	Shear reinforcement provided?	Y	Y	Y	Y	Y	Y	N	N	
C2	Shear reinforcement = bars or wires	Y	Y	N	N	Y	N			E
C3	Shear reinforcement = steel "I" or channel shapes (shearheads)?	Y	N	Y	N	N	Y			L
C4	Opening in slab at a distance $\leq$ 10 times slab thickness from a concentrated load or reaction area <u>or</u> opening in slab within column strip?	I	Y	Y	I	N	N	Y	N	S E
A1*	Critical section 1					X			X	
A2**	Critical section 2						X			
A3†	Critical section 3		X					X		
A4††	Critical section 4			X						
A5	$V_n = V_c = \min\left[\left(2 + \frac{4}{\beta_c}\right)\sqrt{f'_c}\, b_{o1} d,\ 4\sqrt{f'_c}\, b_{o1}\right]$							X	X	
A6	$V_c = 2\sqrt{f'_c}\, b_{o1} d$		X			X				
A7	No Provision, DLT Chapter 11	X			X					
A8	DLT 11.11(d)		X			X				
A9	DLT 11.11(g)			X			X			
A10	DLT 11.11(f)							X	X	
A11	Logical Error									X

* Critical Section 1 is perpendicular to the plane of the slab and located so that its perimeter, b_{o1} , is a minimum. The critical section is $\geq d/2$ from the perimeter of concentrated load or reaction area.

** Critical section 2 is perpendicular to the plane of the slab and crosses each shearhead arm at a distance $(3/4)[\ell_y - (c/2)]$ from column fact to end of shearhead arm. Critical section is located so that its perimeter b_{o2} is a minimum and is $\geq d/2$ from the perimeter of the column section.

† Critical section 3 is the same as 2 except that part of the perimeter that is enclosed by straight lines, projecting from the center of the load or reaction area and target to the boundaries of the openings shall be considered ineffective.

†† Critical section 4 is the same as 3 except the ineffective portion of the perimeter is one-half of that defined for critical section 3.

Datum 11.11(d)	Source	Label	Number
Factored shear force at section.	X	V_u	
Strength reduction factor.	X	ϕ	
Nominal shear strength provided by concrete.	DLT 11.11(c)	V_c	

DLT 11.11(d) Strength Check - 1		1	2
C1	$V_u \leq \phi V_c$?	Y	N
A1	Provision = satisfied, DLT Chapter 11	X	
A2	DLT 11.11(e)		X

Comments:

1) DLT 11.11(d) partially covers Sections 11.11.3.3 and 11.11.3.5.
2) If $V_u \leq \phi V_c = \phi[2\sqrt{f'_c}\, b_o d]$, it is assumed that no calculations are required for the reinforcement.

---

* Shear strength shall be investigated at the critical section defined in Footnote 11.11(c)* and at successive sections from the support.

Datum 11.11(e)	Source	Label	Number
If area, A_v of reinforcement calculated in accordance with provisions of Section 11.5.	X		
If shear strength, V_s, calculated in accordance with Section 11.5.	X		
If reinforcement anchored in accordance with Section 12.14.	X		
Perimeter of critical section for slabs and footings, in.	X	b_o	
Distance from extreme compression fiber to centroid of longitudinal tension reinforcement, but need not be less than 0.80h for prestressed members, in. (For circular sections, d need not be less than the distance from extreme compression fiber to centroid of tension reinforcement in opposite half of member.)	X	d	
The square root of the specified compressive strength of concrete, psi.	X	$\sqrt{f'_c}$	
Nominal shear strength provided by concrete.	DLT 11.11(c)	V_c	

DLT 11.11(e) A_v, V_s, Anchorage		1	2	3	4
C1	Area, A_v, of reinforcement calculated in accordance with provisions of Section 11.5?	Y	Y	Y	N
C2	Shear strength, V_s, calculated in accordance with Section 11.5?	Y	Y	N	I
C3	Reinforcement anchored in accordance with Section 12.14?	Y	N	I	I
A1	Provision = satisfied	X			
A2	V_s = value calculated per Section 11.5	X			
A3	$V_n = \min[(V_c + V_s), 6\sqrt{f'_c}\, b_o d]$	X			
A4	Provision ≠ satisfied, DLT Ch. 11		X	X	X
A5	DLT 11.11(f)	X			

Comments: 1) DLT 11.11(e) covers Sections 11.11.3.5, 11.11.3.1 and 11.11.3.2.

Datum 11.11(f)	Source	Label	Number
Factored shear force of section.	X	V_u	
Strength reduction factor.	X	ϕ	
Nominal shear strength.	DLT 11.11(e)	V_n	

DLT 11.11(f) Strength Check - 2		1	2
C1*	$V_u \leq \phi V_n$?	Y	N
A1	Provision = satisfied	X	
A2	Provision ≠ satisfied		X
A3	DLT Chapter 11	X	X

Comment:

1) DLT 11.11(f) covers Sections 11.11.1.1 and 11.11.3.3.

* Shear strength shall be investigated at the critical section defined in Footnote 11.11(c) and at successive sections from the support.

Datum 11.11(g)	Source	Label	Number
If shear transferred at interior column supports.	X		

DLT 11.11(g) Shear Transfer		1	2
C1	Shear transferred at interior column supports?	Y	N
A1	DLT 11.11(h)	X	
A2*	No Provision, DLT Chapter 11		X

Comment:

1) DLT 11.11(g) covers Section 11.11.4.

* Where shear is transferred at edge or cover column supports, special designs are required.

Datum 11.11(h)	Source	Label	Number
If shearhead consists of steel shapes fabricated by welding into four identical arms at right angles continuous through column section.	X		
Depth of shearhead $\leq$ 70 times web thickness of steel shape.	X		

DLT 11.11(h) Shearhead Configuration - 1		1	2	3
C1	Shearhead consists of steel shapes fabricated by welding into four identical arms at right angles continuous through column section?	Y	Y	N
C2	Depth of shearhead $\leq$ 70 times the web thickness of steel shape?	Y	N	I
A1	Provision = satisfied	X		
A2	Provision $\neq$ satisfied, DLT Ch. 11		X	X
A3	DLT 11.11(i)	X		

Comments: 1) DLT 11.11(h) covers Sections 11.11.4.1 and 11.11.4.2.

2) Checking is terminated here if C1 is N because the rest of the provisions in Section 11.11.4 become inapplicable.

Datum 11.11(i)	Source	Label	Number
If end of shearhead arm cut at an angle $\geq 30^\circ$ with the horizontal.	X		
If plastic moment strength of remaining tapered section adequate to resist the shear force attributed to the cut arm of the shearhead.	X		

DLT 11.11(i) Shearhead Configuration - 2		1	2	3	4
C1	End of shearhead arm cut at an angle $\geq 30^\circ$ with the horizontal?	Y	Y	N	N
C2	Plastic moment strength of remaining tapered section adequate to resist the shear force attributed to the cut arm of the shearhead?	Y	N	Y	N
A1	Provision = satisfied	X			
A2	Provision ≠ satisfied		X	X	X
A3	DLT 11.11(j)	X	X	X	X

Comment: 1) DLT 11.11(i) covers Section 11.11.4.3.

Datum 11.11(j)	Source	Label	Number
If distance from compression flange of steel shape to compression surface of slab ≤ 0.3 d.	X		
Distance from extreme compression fiber to centroid of longitudinal tension reinforcement, but need not be less than 0.80h for prestressed members, in. (For circular sections, d need not be less than the distance from extreme compression fiber to centroid of tension reinforcement in opposite half of member.)	X	d	
Ratio of stiffness of shearhead arm to surrounding composite slab section.	X	α_v	
Size of rectangular or equivalent rectangular column, capital, or bracket measured transverse to the direction of the span for which moments are being determined, in.	X	C_2	

DLT 11.11(j) Stiffness		1	2	3
C1	Distance from compression flange of steel shape to compression surface of slab ≤ 0.3 d?	Y	Y	N
C2	$\alpha_v \geq 0.15$?	Y	N	I
A1	Provision = satisfied	X		
A2	Provision ≠ satisfied		X	X
A3	DLT 11.11(k)	X	X	X

Comments: 1) DLT 11.11(j) covers Sections 11.11.4.4 and 11.11.4.5.

Datum 11.11(k)	Source	Label	Number
Length of shearhead arm from centroid of concentrated load or reaction, in.	X	ℓ_v	
Strength reduction factor for flexure.	X	ϕ	
Plastic moment strength of shearhead provided.	X	M_p	
Size of rectangular or equivalent rectangular column, capital, or bracket measured in the direction of the span for which moments are being determined, in.	X	C_1	
Total depth of shearhead cross section, in.	X	h_v	
Specified compressive strength of concrete, psi.	X	f'_c	
Perimeter of critical sections for slabs and footings - Footnote 11.11(c).	X	b_{o2}	
Perimeter of critical sections for slabs and footings - Footnote 11.11(c).	X	b_{o1}	
Factored shear force at section.	X	V_u	

DLT 11.11(k) Plastic Moment		1	2
C1	ϕM_p (provided) $= \frac{V_u}{8}\left[h_v + \alpha_v\left(\ell_v - \frac{C_1}{2}\right)\right]$?	Y	N
A1	Provision = satisfied	X	
A2	Provision ≠ satisfied		X
A3	$V_{n1} = 4\sqrt{f'_c}\, b_{o2} d$	X	X
A4	$V_{n2} = 7\sqrt{f'_c}\, b_{o1} d$	X	X
A5	DLT 11.11(ℓ)	X	X

Comment:

1) DLT 11.11(k) covers Sections 11.11.4.6, 11.11.4.7, and 11.11.4.8.

2) The Commentary defines ℓ_v as the length from the center of the column to the point at which the shearhead is no longer required. This definition is necessary for the last phrase in Section 11.11.4.6 to have meaning. The definition in Datum 11.11(k) above is from Chapter 11 notation.

Datum 11.11(ℓ)	Source	Label	Number
Shear strength at critical section 1.	DLT 11.11(k)	V_{n1}	
Shear strength at critical section 2.	DLT 11.11(k)	V_{n2}	
Strength reduction factor.	X	ϕ	
Factored shear force at section.	X	V_u	

DLT 11.11(ℓ) Strength Check - 1		1	2	3
C1	$V_u \leq \phi V_{n1}$?	Y	Y	N
C2	$V_u \leq \phi V_{n2}$?	Y	N	I
A1	Provision = satisfied	X		
A2	Provision ≠ satisfied		X	X
A3	DLT 11.11(m)	X	X	X

Comments: 1) DLT 11.11(ℓ) covers Section 11.11.1.

Datum 11.11(m)	Source	Label	Number
If shearhead assumed to contribute a moment resistance.	X		
Strength reduction factor.	X	ϕ	
Factored shear force at section.	X	V_u	
Ratio of stiffness of shearhead arm to surrounding composite slab section.	X	α_r	
Size of rectangular or equivalent rectangular column, capital or bracket measured in the direction of the span for which moments are being determined.	X	C_1	
Length of shearhead arm actually provided from centroid of concentrated load or reaction.	X	ℓ_r	
Total depth of shearhead cross section.	X	h_r	
Total factored moment required for each slab column strip.	X	FM_{cs}	
Change in column strip moment over length ℓ_r.	X	DM	

(Continued)

DLT 11.11(m) Allowable Moment Resistance of Shearhead		1	2
C1	Shearhead assumed to contribute a moment resistance?	Y	N
A1	Provision = satisfied	X	X
A2	$M_{r1} = \frac{\phi \alpha_r V_u}{8} \left(\ell_r - \frac{C_1}{2} \right)$	X	
A3	$M_{r2} = 0.3\ FM_{cs}$	X	
A4	$M_{r3} = DM$	X	
A5	$M_{r4} = \frac{V_u}{\phi 8} \left[h_r + \alpha_r \left(\ell_r - \frac{C_1}{2} \right) \right]$	X	
A6	DLT 11.11(n)	X	
A7	DLT Chapter 11		X

Comments:

1) DLT 11.11(m) partially covers Section 11.11.4.9.

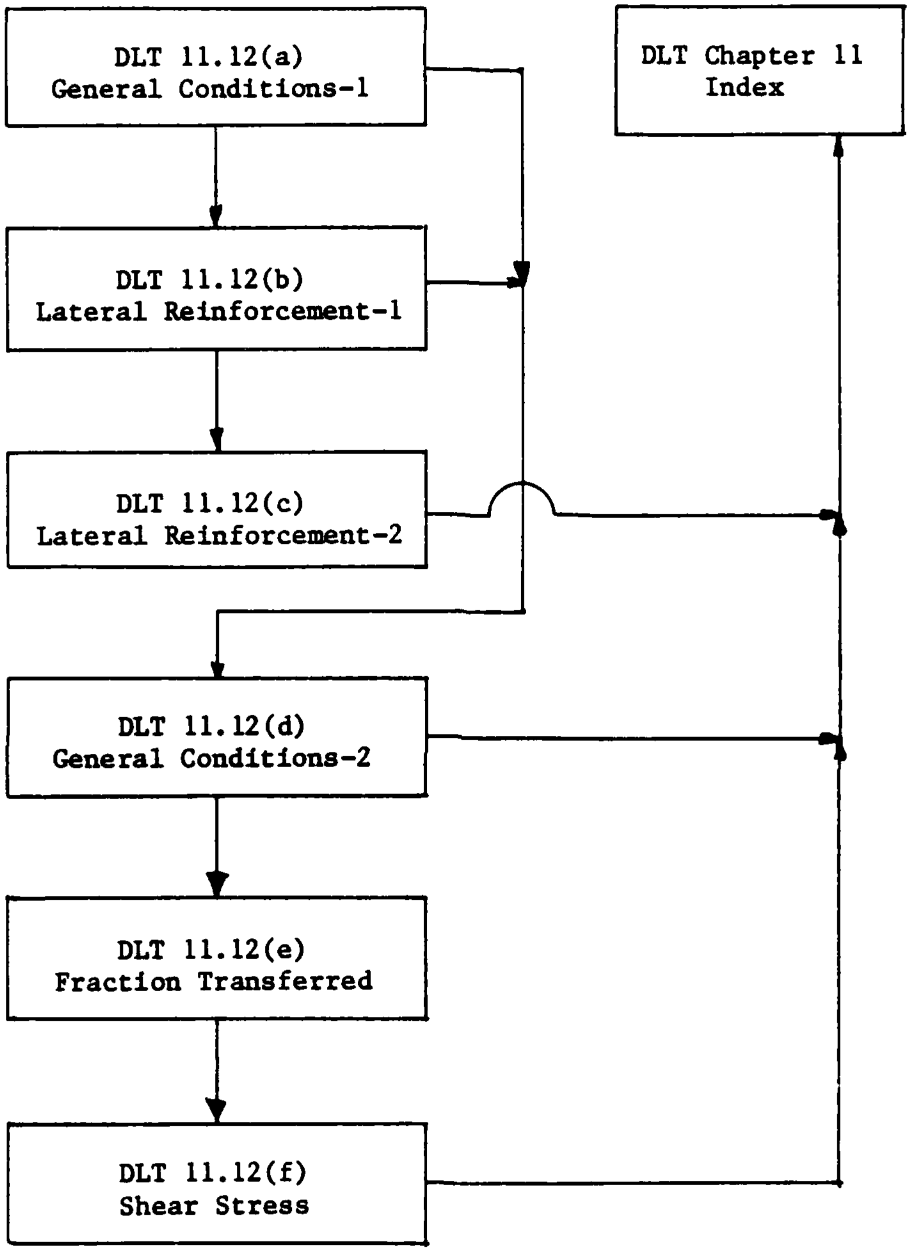
2) In Code paragraph 11.11.4.6, plastic moment, M_p, required shall be computed by Eq (11.38) which includes the strength reduction factor ϕ. It is assumed that the value M_p is equal to Eq (11.38) multiplied by $1/\phi$.

Datum 11.11(n)	Source	Label	Number
Value of moment assumed resisted by shearhead in the design.	X	RM	
Allowable shearhead moment resistance.	DLT 11.11(m)	M_{ri} i=1,2,3,4	

DLT 11.11(n) Strength Check - 2		1	2
C1	$RM \leq \min\left[M_{r1}, M_{r2}, M_{r3}, M_{r4}\right]$?	Y	N
A1	Provision = satisfied	X	
A2	Provision ≠ satisfied		X
A3	DLT Chapter 11	X	X

Comment: 1) DLT 11.11(n) covers Section 11.11.4.9.

Section 11.12 Map



Section 11.12 Transfer of Moment to Columns

Datum 11.12(a)	Source	Label	Number
If gravity load, wind, earthquake or other lateral forces cause transfer of moment at connections of framing elements to columns.	X		
If shear resulting from moment transfer considered in design of lateral reinforcement in columns.	X		

DLT 11.12(a) General Conditions - 1		1	2	3	
C1	Gravity load, wind, earthquake, or other lateral forces cause transfer of moment at connections of framing elements to columns?	Y	Y	N	ELSE
C2	Shear resulting from moment transfer considered in design of lateral reinforcement in columns?	Y	N		
A1	Provision = satisfied	X			
A2	Provision ≠ satisfied		X		
A3	DLT 11.12(b)	X			
A4	DLT 11.12(d)			X	
A5	DLT Chapter 11		X		
A6	Logical Error				X

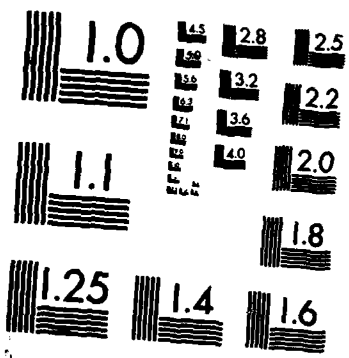
Comments: 1) DLT 11.12(a) covers Section 11.12.1.1.

Datum 11.12(b)	Source	Label	Number
If connection not part of primary seismic load resisting system that is restrained on four sides by beams or slabs of approximately equal depth.	X		
Web width, or diameter of circular section, in.	X	b_w	
Spacing of shear or torsion reinforcement in direction parallel to longitudinal reinforcement, in.	X	s	
Specified yield strength of nonprestressed reinforcement, psi.	X	f_y	

DLT 11.12(b) Lateral Reinforcement - 1		1	2
C1	Connection not part of primary seismic load resisting system that is restrained on four sides by beams or slabs of approximately equal depth?	Y	N
A1	$A_{v(min)} = 50\ b_w s/f_y$		X
A2	No shear reinforcement required in the joint region of beam column connection.	X	
A3	DLT 11.12(c)		X
A4	DLT 11.12(d)	X	

Comments: 1) DLT 11.12(b) covers Section 11.12.1.2.

AD-A173 663 COMPUTER-AIDED STRUCTURAL ENGINEERING (CASE) PROJECT: 6/6
DECISION LOGIC TABL (U) ATKINSON-NOLAND & ASSOCIATES
INC BOULDER CO J L NOLAND JUL 86 ATC-TR-86-5-VOL-1
UNCLASSIFIED DACW39-82-M-3741 F/G 9/2 NL


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
6.3
7.1
8.0
9.0
10

Datum 11.12(c)	Source	Label	Number
Area of shear reinforcement within a distance s, used in design, sq in.	X	A_v	
Minimum area of shear reinforcement within a distance s, sq in.	DLT 11.12(b)	$A_{v(min)}$	

DLT 11.12(c) Lateral Reinforcement - 2		1	2
C1	$A_v \geq A_{v(min)}$?	Y	N
A1	Provision = satisfied	X	
A2	Provision ≠ satisfied		X
A3	DLT Ch. 11	X	X

Comments: 1) DLT 11.12(c) covers Section 11.12.1.2.

Datum 11.12(d)	Source	Label	Number
If gravity load, wind, earthquake, or other lateral forces cause transfer of moment between slab and column.	X		
Size of rectangular or equivalent rectangular column, capital, or bracket measured in the direction of the span for which moments are being determined, in.	X	C_1	
Size of rectangular or equivalent rectangular column, capital, or bracket measured transverse to the direction of the span for which moments are being determined, in.	X	C_2	
Distance from extreme compression fiber to centroid of longitudinal tension reinforcement, but need not be less than 0.80h for prestressed members, in. (For circular sections, d need not be less than the distance from extreme compression fiber to centroid of tension reinforcement in opposite half of member.)	X	d	

DLT 11.12(d) General Conditions - 2		1	2
C1	Gravity load, wind, earthquake, or other lateral forces cause transfer of moment between slab and column?	Y	N
A1	$\gamma_v = 1 - 1/\left(1 + \frac{2}{3}\sqrt{\frac{C_1 + d}{C_2 + d}}\right)$	X	
A2	Critical section = section perpendicular to plane of slab and located so that its perimeter is a minimum and not closer than d/2 to perimeter of columns.	X	
A3	DLT 11.12(e)	X	
A4	DLT Chapter 11		X

Comment:

1) DLT 11.12(d) covers Sections 11.12.2.1 and 11.12.2.3.

Datum 11.12 (e)	Source	Label	Number
If fraction of unbalanced moment = γ_v transferred by eccentricity of shear about the centroid of a critical section.	X		
Fraction of unbalanced moment transferred by eccentricity of shear at slab column connections.	DLT 11.12(d)	γ_v	
Fraction of unbalanced moment <u>not</u> transferred by eccentricity of shear transferred by flexure per Section 13.3.4.	X		
Strength reduction factor.	X	ϕ	
Square root of specified compressive strength of concrete, psi.	X	$\sqrt{f'_c}$	
Ratio of long side to short side of concentrated load or reaction area.	X	β_c	

DLT 11.12(e) Fraction Transferred		1	2	3
C1	Fraction = γ_v of unbalanced moment transferred by eccentricity of shear about centroid of critical section?	Y	Y	N
C2	Fraction of unbalanced moment not transferred by eccentricity of shear transferred by flexure per Section 13.3.4?	Y	N	I
A1	Provision = satisfied	X		
A2	Provision ≠ satisfied		X	X
A3	$f_v = \min\left[\phi\left(2+\frac{4}{\beta_c}\right),\ 4\sqrt{f'_c}\right]$	X	X	X
A4	DLT 11.12(f)	X	X	X

Comments: 1) DLT 11.12(e) covers Section 11.12.2.2, 11.12.2.3, and part of Section 11.12.2.4.

Datum 11.12(f)	Source	Label	Number
If shear stress due to factored shear forces and moments.	X		
Maximum shear stress allowed.	DLT 11.12(e)	f_v	
If shear stress resulting from moment transfer by eccentricity of shear assumed to vary linearly about centroid of critical section as defined by Section 11.12.2.3.	X		

DLT 11.12(f) Shear Stress		1	2	3
C1	Shear stress due to factored shear forces and moments $\leq f_v$?	Y	Y	N
C2	Shear stress resulting from moment transfer by eccentricity of shear assumed to vary linearly about centroid of critical section as defined by Section 11.12.2.3?	Y	N	I
A1	Provision = satisfied	X		
A2	Provision ≠ satisfied		X	X
A3	DLT Ch. 11	X	X	X

Comments: 1) DLT 11.12(f) covers Section 11.12.2.4.

WATERWAYS EXPERIMENT STATION REPORTS PUBLISHED UNDER THE COMPUTER-AIDED STRUCTURAL ENGINEERING (CASE) PROJECT

	Title	Date
Technical Report K-78-1	List of Computer Programs for Computer-Aided Structural Engineering	Feb 1978
Instruction Report O-79-2	User's Guide: Computer Program with Interactive Graphics for Analysis of Plane Frame Structures (CFRAME)	Mar 1979
Technical Report K-80-1	Survey of Bridge-Oriented Design Software	Jan 1980
Technical Report K-80-2	Evaluation of Computer Programs for the Design/Analysis of Highway and Railway Bridges	Jan 1980
Instruction Report K-80-1	User's Guide: Computer Program for Design/Review of Curvilinear Conduits/Culverts (CURCON)	Feb 1980
Instruction Report K-80-3	A Three-Dimensional Finite Element Data Edit Program	Mar 1980
Instruction Report K-80-4	A Three-Dimensional Stability Analysis/Design Program (3DSAD)	
	Report 1: General Geometry Module	Jun 1980
	Report 3: General Analysis Module (CGAM)	Jun 1982
	Report 4: Special-Purpose Modules for Dams (CDAMS)	Aug 1983
Instruction Report K-80-6	Basic User's Guide: Computer Program for Design and Analysis of Inverted-T Retaining Walls and Floodwalls (TWDA)	Dec 1980
Instruction Report K-80-7	User's Reference Manual: Computer Program for Design and Analysis of Inverted-T Retaining Walls and Floodwalls (TWDA)	Dec 1980
Technical Report K-80-4	Documentation of Finite Element Analyses	
	Report 1: Longview Outlet Works Conduit	Dec 1980
	Report 2: Anchored Wall Monolith, Bay Springs Lock	Dec 1980
Technical Report K-80-5	Basic Pile Group Behavior	Dec 1980
Instruction Report K-81-2	User's Guide: Computer Program for Design and Analysis of Sheet Pile Walls by Classical Methods (CSHTWAL)	
	Report 1: Computational Processes	Feb 1981
	Report 2: Interactive Graphics Options	Mar 1981
Instruction Report K-81-3	Validation Report: Computer Program for Design and Analysis of Inverted-T Retaining Walls and Floodwalls (TWDA)	Feb 1981
Instruction Report K-81-4	User's Guide: Computer Program for Design and Analysis of Cast-in-Place Tunnel Linings (NEWTUN)	Mar 1981
Instruction Report K-81-6	User's Guide: Computer Program for Optimum Nonlinear Dynamic Design of Reinforced Concrete Slabs Under Blast Loading (CBARCS)	Mar 1981
Instruction Report K-81-7	User's Guide: Computer Program for Design or Investigation of Orthogonal Culverts (CORTCUL)	Mar 1981
Instruction Report K-81-9	User's Guide: Computer Program for Three-Dimensional Analysis of Building Systems (CTABS80)	Aug 1981
Technical Report K-81-2	Theoretical Basis for CTABS80: A Computer Program for Three-Dimensional Analysis of Building Systems	Sep 1981
Instruction Report K-82-6	User's Guide: Computer Program for Analysis of Beam-Column Structures with Nonlinear Supports (CBEAMC)	Jun 1982
Instruction Report K-82-7	User's Guide: Computer Program for Bearing Capacity Analysis of Shallow Foundations (CBEAR)	Jun 1982

(Continued)

WATERWAYS EXPERIMENT STATION REPORTS PUBLISHED UNDER THE COMPUTER-AIDED STRUCTURAL ENGINEERING (CASE) PROJECT

(Concluded)

	Title	Date
Instruction Report K-83-1	User's Guide: Computer Program With Interactive Graphics for Analysis of Plane Frame Structures (CFRAME)	Jan 1983
Instruction Report K-83-2	User's Guide: Computer Program for Generation of Engineering Geometry (SKETCH)	Jun 1983
Instruction Report K-83-5	User's Guide: Computer Program to Calculate Shear, Moment, and Thrust (CSMT) from Stress Results of a Two-Dimensional Finite Element Analysis	Jul 1983
Technical Report K-83-1	Basic Pile Group Behavior	Sep 1983
Technical Report K-83-3	Reference Manual: Computer Graphics Program for Generation of Engineering Geometry (SKETCH)	Sep 1983
Technical Report K-83-4	Case Study of Six Major General-Purpose Finite Element Programs	Oct 1983
Instruction Report K-84-2	User's Guide: Computer Program for Optimum Dynamic Design of Nonlinear Metal Plates Under Blast Loading (CSDOOR)	Jan 1984
Instruction Report K-84-7	User's Guide: Computer Program for Determining Induced Stresses and Consolidation Settlements (CSETT)	Aug 1984
Instruction Report K-84-8	Seepage Analysis of Confined Flow Problems by the Method of Fragments (CFRAG)	Sep 1984
Instruction Report K-84-11	User's Guide for Computer Program CGFAG, Concrete General Flexure Analysis with Graphics	Sep 1984
Technical Report K-84-3	Computer-Aided Drafting and Design for Corps Structural Engineers	Oct 1984
Technical Report ATC-86-5	Decision Logic Table Formulation of ACI 318-77, Building Code Requirements for Reinforced Concrete for Automated Constraint Processing, Volumes I and II	Jun 1986

END

12-86

DTIC